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Ground Forces Battle Casualty Rate Patterns

Current Rate Projections Compared to the Empirical Evidence

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A 4-year study of modern conventional ground operations (reported in 3 volumes: LMI FP703TR1/-TR2/-TR3) reveals patterns of personnel battle casualty rates strongly associated with patterns of operations. This second volume extends the first volume's discussion of empirical evidence (especially on differences between continuous and disrupted front rates), spends considerable time comparing simulation output to patterns noted in empirical evidence, and discusses the origins and character of various U.S. and Allied estimation methodologies. Overall, the research combines insights from military theory, history, and operations research to investigate a new and large body of empirical data (from WWII, Korea, Middle East, and National Training Center – much of it included in the first volume) on battle casualty rate behavior in modern conventional operations. Findings include detailed and general rate characteristics associated qualitatively and quantitatively with major forms of operations. Qualitative indicators include critical operational parameters for rate assessment, and fundamental operational scenario characteristics. Quantitative indicators include probable ranges of average (mean) rates for army and corps-size forces for varying time periods and scenarios, distributions (max, 75, median, 25, min) of 1-day rates given those averages (for 5- and 10-day periods), measures of rate variability, rate frequencies, varying proportions of wounded casualties out of total, etc. Findings suggest that current U.S. and Allied casualty estimation methodologies and contemporary simulations fail to represent significant empirically-indicated rate patterns, and further suggest the character and degree of the misrepresentation. An improved approach is described to casualty estimation (to evaluate estimates made by whatever method or to construct estimates). [Note: a separate paper by the author summarizes and elaborates on the research (including descriptions of how to use the data and patterns to critique simulation output), and discusses Operation Desert Storm results in light of the study's prior insights into rate patterns. See "Ground Forces Battle Casualty Rate Patterns: Uses in Casualty Estimation and Simulation Evaluation," prepared for the Military Operations Research Society, October 1992. Also in DTIC.]

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The U.S. Army Soviet Army Studies Office (SASO) at Ft. Leavenworth, Kansas, conducts studies of Soviet and Warsaw Pact military practice in support of high-level U.S. Army commands. Its small staff of experts is undoubtedly among the best qualified in the world in the study of Soviet military theory, history, force structure, and practices. We sought that expertise in our attempt to understand both the experience of the German Army in World War II on the Eastern Front against Soviet forces and methods and the contemporary character of Soviet forces and methods. SASO, like CAA, unhesitatingly contributed time and effort to support this study. Again, we owe a particular debt of appreciation to SASO's director of research, COL David M. Glantz, for his unstinting assistance and invaluable insights.

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PREFACE

This report is our second in a series researching battle casualty rates for modern conventional ground warfare. The first report outlined the character of those rates as shown in actual operations from World War II through the late-1980s. This report compares certain current U.S. and Allied rate projections for Europe to the nature of rates and patterns as seen in the empirical evidence. The third report will propose certain ranges and distributions of rates for use in planning that better reflect the behavior of rates suggested by the empirical evidence.

Each report will later be issued as a final report. We would therefore encourage readers to communicate their comments, and any questions or suggestions, as they receive the interim reports. The subject is complex, and we have been unable to include all relevant data and supporting information in this report. Reader response will help identify issues or points that may need clarification or elaboration or, of course, further consideration.

LMI

Executive Summary

GROUND FORCES BATTLE CASUALTY RATE PATTERNS: CURRENT RATE PROJECTIONS COMPARED TO THE EMPIRICAL EVIDENCE

Personnel casualty rates drive planning requirements for medical force structure, replacements, and the training base. They also play a primary role in assessing a force's potential effectiveness in various scenarios, hence its likelihood of success in pursuing national policy.

This task evaluates the reasonableness of battle casualty rate projections. This second report in a series compares the major current U.S. and Allied rate projections for Europe to the nature of rates and patterns as seen in the empirical evidence.

The research confirms our earlier observation of three significant mismatches. First, certain major projections – given their planning scenarios – are at least twice too high for peak-rate (10-day) periods than the evidence from actual operations supports. Such projected peak-rates are usually, in fact, suited only to scenarios in which a theater force suddenly collapses rather than to scenarios (even if pessimistic ones) assumed in planning.

Second, the rate projections fail to suggest realistic distributions of rates which are of particular concern to planners attempting to anticipate requirements over the planning time line. Projections of rate averages over an extended planning time line should show multiple peak-rate periods where now they generally show only one. And while average divisional rates for an army-size force would be lower for such peaks than now often projected, rates for certain sectors within that force could be far higher than now envisioned.

Third, the empirical evidence clearly demonstrates a significant shift in the proportions of casualty types to be expected in certain worst-case defensive scenarios. In real-world operations, those scenarios show a radical increase in missing and captured casualties and a substantial decrease in the proportion of wounded-in-action. None of the projections takes that shift of casualty proportions into account.

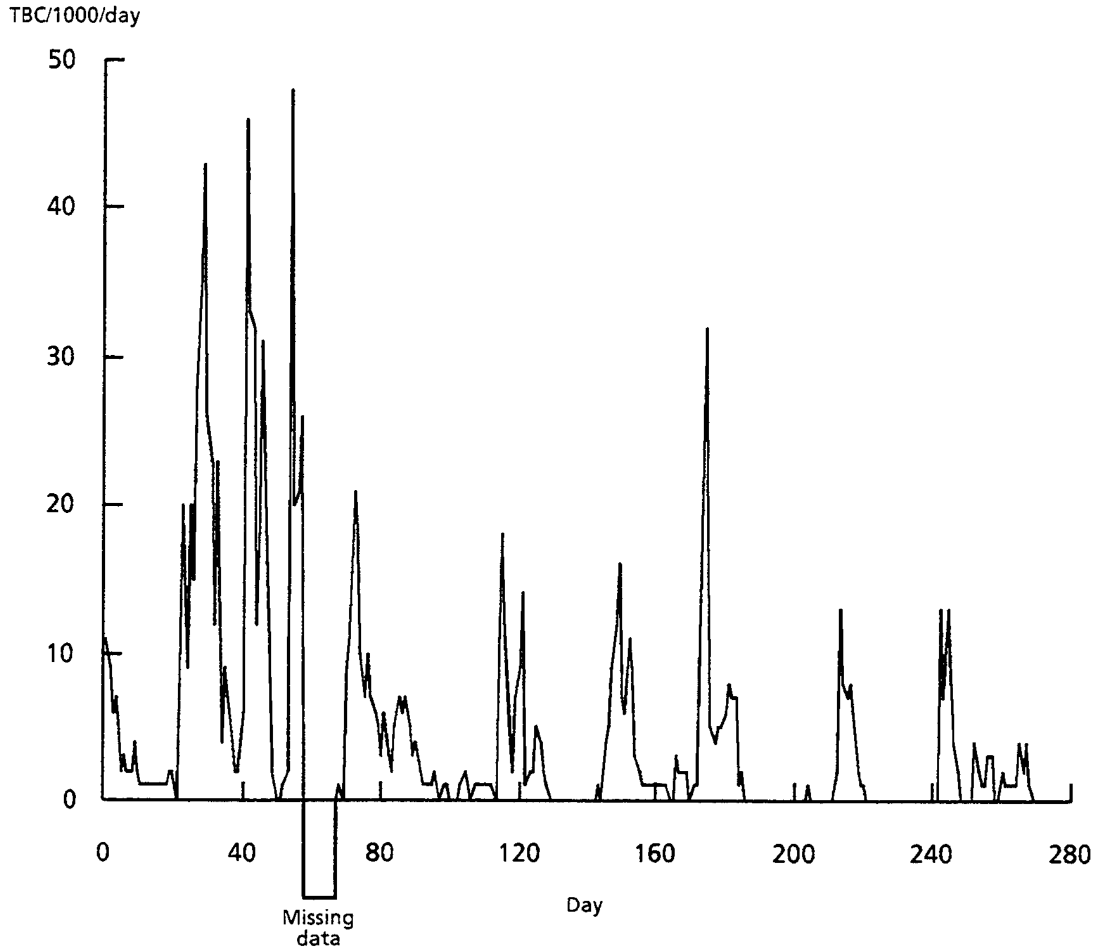
Such fundamental mischaracterizations of possible casualty rates in U.S. and Allied projections inevitably lead to major distortions of planning requirements.

These distortions occur in the set of separate national requirements projections and in the cumulative requirements burden projected within the North Atlantic Treaty Organization (NATO) alliance for the Central Front region as a whole.

The three mischaracterizations of casualty rates are basically caused by the failure of U.S. and Allied rate projection methodologies to pay adequate attention to two kinds of patterns evident in actual operations. The first kind, which we term the underlying quantitative patterns of casualty rates, describes the behavior of rates as they rise and fall over time and across a front. Our earlier report explains how empirical evidence from modern conventional operations reveals patterns of rates strongly associated with the operational parameters of force size, time, and scenario. Rates occur in pulses and with a variability that is dramatic. (The Figure illustrates the time aspect of this first kind of pattern for a one-division force.) Such rate behavior reveals general patterns when quantified in terms of the three operational parameters. We have observed in these patterns a distinction between the characters of rates at the tactical and the operational levels of war that is indispensable for assessing the reasonableness of rate projections.

The second kind of pattern, which we term patterns of operations, describes a structure of major types of operational-level scenarios with which rates are associated. Our first report introduced empirical evidence of a critical distinction between scenarios where the operational front remains continuous (essentially unbroken) despite even successful enemy advances and scenarios where the front becomes disrupted (the defender's cohesion essentially destroyed). This report significantly develops that analysis by describing a hierarchy of operations, and the associated spectrum of casualty rates, evident within these two broad scenario types. Rates for continuous fronts – the scenarios assumed in planning – are distinctly lower than rates seen in most cases of disrupted front scenarios. Yet rates projected for planning scenarios usually show a magnitude and character that, in the real-world data, are associated only with disrupted front situations.

The mismatches between patterns in current casualty rate projections and those found empirically are evident in both of the major types of projection methodology: projections by "calculation" and by "assignment." Some projections are based on actual calculations of rates for the particular forces and setting in question. These projections are done mainly by mathematical simulations. However, most casualty rate projections are still provided by methodologies that take rate



30th U.S. INFANTRY DIVISION (June 1944-April 1945)
Total Battle Casualties (TBC) per 1000 Personnel Per Day

values determined independently of any given operational scenario being considered, and assign those values to that scenario as seems appropriate.

We examine in detail representative output of the current calculation methodology supporting the U.S. Army Staff's rate projections. We also evaluate rate projections, and discuss certain features of assignment methodologies, for U.S. Army and U.S. Marine Corps forces in Europe, and for the Federal Republic of Germany, the United Kingdom, and the Supreme Headquarters, Allied Powers Europe.

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CHAPTER 1

INTRODUCTION

GENERAL

This is the second report in this series on ground forces battle casualty rates and rate patterns. The first report analyzed and displayed empirical evidence of the nature of casualty rates and rate patterns for modern conventional ground combat. This report compares recent U.S. and Allied casualty rate projections to the insights into rates and patterns that the body of empirical evidence affords.

The first report made two main points. First, a massive body of empirical battle casualty data indicates that casualty rates in modern conventional operations occur in patterns characteristic of certain combinations of force size, time period, and scenario. Insofar as casualty rates are concerned, the central feature of modern ground combat is that it occurs in pulses of activity that are localized in time and space and that produce casualty rates that vary dramatically. The pulses highlight patterns of rates, which may be characterized in terms of the three rather straightforward parameters.

The second point made in the earlier report is that empirical data reveal no evidence of any increase in casualty rates since 1945 for forces of similar size, over similar time periods, and in roughly comparable scenarios.

Our view is that casualty rates used in planning efforts should be reasonably consistent with the empirical evidence of rate patterns and their behavior. If force sizes, time periods, and general operational scenarios are identifiable, planners can also identify patterns of casualty rates – and certain ranges of rates – that are reasonably associated with them. Alternatively, planners may describe the kinds of scenarios most likely associated with a given rate if the force size and time period to which the rate is applied are also identified. In the same vein, planners may identify casualty rates and patterns that are not likely to be associated with a given force, time period, and scenario – that is, rates and patterns that would require special

explanation as to why they are so removed from what, even with broad tolerances, would be expected given the mass of empirical experience.

THE ISSUES

This report in essence asks whether the various major projections of casualty rates underlying current ground forces planning are reasonable when associated with the kinds of force sizes, time periods, and scenarios the planning presumably depicts. Much is at stake.

Clearly, casualty rate projections have a direct impact on military requirements planning for personnel replacements and for medical force structure. Both the magnitudes of peak intensity casualty periods and the distribution of such peaks over the planning period affect requirements. Other supporting requirements (for example, for transportation) then flow from personnel and medical requirements. However, other concerns, beyond this already impressive array of requirements planning issues, are also at stake.

At a minimum, many resource requirements not directly tied to personnel and medical matters are strongly linked to the pace and intensity of combat. Casualty rates are a major index of combat intensity and duration. Less visible, perhaps, but no less important, senior policy makers in various areas share an interest in casualty rates. Rates of some magnitudes may indicate the possibility of a successful national policy, while other rates may indicate the impossibility of achieving some national goal. Stated differently, some casualty rates may indicate military operations that can be successful and are supportable; other rates may betoken operational disaster; still others may represent what in operational terms is essentially impossible and can only beggar credulity.

In all these cases, what may be most fundamentally at issue is whether planners and policy makers understand the operational implications of the casualty rate projections they must rely upon across the spectrum of planning and policy issues. Allocating resources to meet some or all requirements flowing from high but credible casualty rate projections is quite a different proposition from attempting to decide how to support requirements driven by rates that in terms of actual operations are a virtual impossibility. Planners and policy makers can be far better served by the credibility of the casualty rates they are given than is now the case.

Finally, certain assumptions or approaches basic to the very way in which planners and policy makers address these issues may also be at stake. Concern has long been voiced in the defense analytic community that operations research techniques supporting plans and policy judgments often stand aloof from "real-world" insights and data. Concern is perhaps especially great that supporting analyses do not often or adequately address the operational level of war – the level at which most senior planning and policy decisions are focused.

Turning to empirically demonstrated casualty rate patterns offers, we believe, the possibility both that the nature of casualty rates and their implications may be better understood and that approaches to resource planning may gain sounder operational bearings.

CASUALTY RATE PROJECTIONS ADDRESSED

We examine casualty rate projections currently in use by U.S. and Allied planners looking at a potential North Atlantic Treaty Organization (NATO)-Warsaw Pact conflict.[1] The sources of the particular projections examined are:

- **United States**
  - U.S. Army
  - U.S. Marine Corps
- **Allies**
  - Federal Republic of Germany (FRG)
  - United Kingdom (UK)
  - Supreme Headquarters, Allied Powers Europe (SHAPE)

[1]The historic political changes that swept both Eastern Europe and the Soviet Union in 1989-1990, and other developments that were either already in progress or that may now be likely, have fundamentally altered expectations on the possibility of theater war in Europe. This research continues for two reasons. More immediately, planners will continue to be responsible for contingencies that, no matter the reduced degree of probability, remain possible. Until the military capabilities – the actual forces – that represent a potential threat to NATO are concretely and substantially reduced, planners must envision the consequences of their possible use. Beyond this, we believe this research offers insights into the nature of casualty rate patterns in field combat between modern conventional forces and thus offers insights that are potentially useful in other areas and arenas in which such forces might come into conflict.

U.S. Army

Three sets of projections are addressed here. The first, emanating from the U.S. Army Concepts Analysis Agency's (CAA's) extensive mathematical modeling process, supports the Army Staff's (ARSTAF's) planning activities under the Program Objective Memorandum (POM) process. The second, based on use of the Joint Staff's Medical Planning Module by theater Army planners, supports the theater commander's operations plans (OPLANs). The third, found in a planning model developed by the U.S. Army Europe (USAREUR) staff, is intended for use by USAREUR during wartime to project personnel replacements requirements given actual casualty and strength figures as they are reported from Army forces either attached to NATO or still under U.S. command. The same model is used by the USAREUR staff to conduct studies of possible scenarios.

We also comment on the Army's Field Manual (FM) 101-10-1, which serves as the source of the USAREUR model's rates. This manual's rate tables and procedures are an acknowledged general guide to ground force planners' efforts in many nations.

U.S. Marine Corps

The U.S. Marine Corps relies on the Joint Staff's Medical Planning Module process to structure its casualty rate projections for the European theater. The rates currently used in that process for Marine Corps planning derive from a study completed for the Marine Corps in the late-1970s. The Marine Corps contracted for a new study of casualty rates in 1989, and we comment on rate results so far available (which, however, have not yet received official approval nor been incorporated into the planning process).

Allies

The report reviews the casualty rates currently projected by the FRG and the UK for their ground forces in the NATO environment and rates currently recommended by SHAPE for use by NATO member nations that do not have their own methodologies.

UNCLASSIFIED AND CLASSIFIED PARTS OF THIS REPORT

This second report follows the practice of the first in separating the discussion of issues and observations about casualty rates that are unclassified and may be of

general interest to the analytic community from those issues and observations concerning actual planning figures that are classified.

CHAPTER 2

METHODOLOGICAL REVIEW AND CONSIDERATIONS

GENERAL

This report relies heavily on the analysis of casualty rates and patterns, and on the findings, presented in our first report.[1] That analysis and those findings have been expanded for this report.[2] Our approach to the problem of characterizing the reasonableness of current casualty rate projections essentially follows the analytic framework and procedures laid down in the earlier report.

Our general approach is to ask whether the projected casualty rates (and their patterns, whether explicit or implicit) fit the empirical casualty rates and patterns for the force sizes, time periods, and broad scenarios the projections attempt to describe.

Clearly, our approach stands on the premise that the rates and patterns of casualties shown in the empirical evidence remain relevant to the kinds of forces, time periods, and scenarios the projections attempt to address. In particular, we use rates and patterns from World War II experience on both the Western Front and the Eastern Front as the bases for critiquing current projections for a European setting.

We must strongly emphasize once more, as in the first report, that this analysis does not rest on some mere appropriation of casualty rate experiences that once happened. To the contrary, our approach rests on discerning systematic patterns or relationships of casualty rates in terms of parameters that are both simple and enduring. The set of empirical data on which the analysis rests includes literally thousands of days of experience, at several echelons (e.g., army, corps, division, and

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[1]Readers who have not reviewed the first report are strongly urged to do so. See LMI Report FP703TR1, *Ground Forces Casualty Rate Patterns: The Empirical Evidence*, Kuhn, George W.S., September 1989.

[2]We expand our analysis of the quantitative characteristics of rates in Chapter 4. We introduce a new categorization (with examples and estimated rates) of disrupted front scenarios in Chapter 5. The categorization includes a description of the operational patterns of major combat events associated with each of the disrupted front types. (See also the section on "Review and Extension of Insights into Rates Against Soviet Operations" in this chapter on pp. 2-4 and 2-5.)

subdivisional), taken from modern ground operations extending from the early-1940s through the late-1980s.[3] Analysis of these data in our first report clearly shows that despite quite conservative assumptions that would favor a finding of higher rates, no empirical evidence indicates that rates since 1945 have increased for comparable force sizes, time periods, and general scenarios. The proper focus, then, is on ascertaining the patterns and rates associated with the force sizes, time periods, and scenarios of planning interest.

We have limited our research into the nature of casualty rates and patterns for conventional forces to the empirical record for several reasons. First, an enormous body of empirical data are available on casualty rates for modern conventional ground operations. If a consistency of rates and patterns exists across the range of these data, then this extensive body of evidence is useful in all its linked parts – as long as distinctive rates and patterns are kept distinct and not inappropriately mixed. Second, we are persuaded by the school of military theory and practice[4] that holds that no revolution has occurred in the *nature* of modern conventional ground operations despite obvious leaps in the one-to-one comparative effectiveness of particular weapons and other systems. Finally, among other concerns, we are not aware of any set of generated casualty rate data that is not wholly dependent on a large number of highly questionable or even demonstrably false assumptions or assertions about the real-world factors and their complex relationships that cause actual casualty rates.

Our heavy reliance on World War II data to discern the patterns of casualty rates is due both to the comprehensiveness and detail of those data (permitting simultaneous, and often daily, looks at multiple echelons in the same time periods and circumstances) and, in particular, to the fact that they alone illustrate the operational level of war and the character of tactical rates as they occur within that larger operational context.

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[3]See especially Chapters 3 and 5 of the first report.

[4]Examples of this school are found in the current field manuals for operations for the U.S. Army and the German Army (to mention but two). This modern approach to conventional operations may be referenced to various antecedents – such as the German introduction of "infiltration tactics" in 1918 and subsequent development of "Blitzkrieg" operations, the Soviet theory and practice of "deep operations" since the 1930s, or the adoption over time of more fluid structures for tactical combat forces (such as the U.S. Army's turn to the "triangular" division prior to World War II).

Empirical data show that patterns of casualty rates are associated with certain force sizes (surrogate: echelon), time period (or duration measured), and scenario (which determines sector type and number). Moreover, patterns of rates exist that are distinctive to the operational and tactical levels of war. On the basis of patterns alone, then, a critique of current casualty rate projections is possible: do they manifest patterns of rates properly associated with the echelon, time period, and scenario they attempt to represent?

However, the analysis does not rest solely on rate patterns. The empirical evidence is clear – at least at the tactical level, which is the only level for which reliable data are available for post-1945 operations – that rates for comparable force sizes, time periods, and scenarios have not increased since World War II.

The first report concludes its analysis of rates since World War II by looking at rates sustained by U.S. battalions in intense, 1-day mock combat with Soviet-style units. The rates seen there are no greater than rates for roughly comparable situations in World War II western theaters of operations – and are probably lower, if the very conservative leanings of several qualifications made in our previous report are recognized. That rates for intense 1-day encounters at the battalion level – that is, rates at the "hottest spots" along a front – are no higher today means that the focus of analysis properly returns from that granular perspective to a broader view from the higher tactical and operational levels.

The question becomes one of whether we have sufficient reason to believe that the composition of corps and army rates – which are, of course, necessarily grounded in the configurations of their lower-level tactical units' experiences in those higher-level settings – may have changed significantly since World War II. The answer lies in whether operational structures and methods have changed to such an extent that the general nature or shape of combat interactions – the patterns of overall ebb and flow of the granules, as it were – has changed significantly.

We are persuaded by that military judgment that the general shape of operational interactions, in the sense just described, has not changed significantly. The World War II data from both major (eastern and western) theaters covers a broad – and still comprehensive, given developments since then in combat doctrine, force structure, and practice – array of combat organizational and operational practices. Within that array, the Soviet approach to the operational art continues to

be well described by the overall set of operations it conducted in its theater. Indeed, the set of those operations serves as a kind of paradigm for Soviet planners to this day – different particulars will be stressed as applicable to differing particular circumstances, but the horizon for operational planning remains defined in that set of operations.[5]

Therefore, the close linkages laid out in the first report are fundamental: (1) between the structure of operational and tactical German casualty rates seen on the Eastern Front against even massively successful Soviet operations and those rates experienced on the Western Front by Allied forces, and (2) between the tactical elements in those sets of rates and the tactical rates experienced since World War II (including those in quite recent exercises against Soviet-style forces and methods). Those linkages describe a coherent relationship between operational and tactical rates in modern operations, and between the magnitudes of those rates and certain kinds of force size, time period, and scenario.

The critique of current rate projections may thus stand on two grounds: the patterns of rates, and the magnitudes of rates found in those patterns. The critique must link the empirical and planning rates in terms of appropriate force size, time period, and general operational scenario.

REVIEW AND EXTENSION OF INSIGHTS INTO RATES AGAINST SOVIET OPERATIONS

A major concern in our first report was whether, in World War II, German defenders facing Soviet operational approaches experienced casualty rates comparable to those experienced by the Allies in the West. We found they did – with important qualifications.

When one accounts for force size, time period, and general scenario, the German rates seen on the Eastern Front are no higher than Allied rates in the West. Care must be taken to fully understand this observation with its obvious emphasis on qualification. It does not mean that no German casualty rates were higher than

[5]For example, Soviet thinkers refer to the Vistula-Oder and the Kursk campaigns as exemplars, respectively, of offensive and defensive planning. Both rested on the same Soviet concept and practice of the operational art. As noted by several observers of Soviet theory and practice, the Kursk *defensive* operation was merely the first of a two-part overall plan aimed principally at major *offensive* operations (e.g., Belgorod-Kharkov).

those in the West. We carefully pointed out that certain scenarios in the East – which we referred to as "disrupted" operational fronts – were never experienced by the Allies in the West. The Allies saw only "continuous" fronts.

At the time we published our first report, rates for disrupted fronts taken as operational wholes appeared always to be significantly higher than those for continuous fronts. We discussed one case of such a disrupted scenario in the East for which we have extensive data. The Lvov-Sandomierz operation shows the German 10-day army casualty rate to be nearly 40 percent higher than the worst army 10-day rate seen in the West.

Yet even in cases of disrupted fronts, the German casualty rates in the Soviet breakthrough sectors were no worse than those of the Allies in similar circumstances in the Western theater. One merely had to turn to the appropriate setting in the West – in the case of breakthrough sectors, for example, to the one instance in the West of an operational-level breakthrough sector (during the Ardennes "Bulge" campaign in December 1944). Moreover, apart from these distinctive disrupted front scenarios as wholes, we found that German rates in the East (even many rates for units within a disrupted front scenario) and Allied rates in the West were closely comparable.

To restate, in the first report we found that rates on the Western and Eastern Fronts were not essentially different in terms of magnitudes when seen in their proper patterns: the appropriate contexts of force size, time period, and scenario.

Our continued analysis of the Eastern Front experience now affords a far fuller view of casualty rates for forces facing Soviet operational approaches. We have identified levels of casualty rates associated with what in essence is a 4-tiered structure of disrupted front scenarios. The rates for this structure of scenarios in fact overlap rates found in continuous front settings.

We discuss these insights and review the differences between continuous and disrupted front scenarios in Chapter 5.

REVIEW OF PATTERNS ANALYZED

Figure 2-1 illustrates notionally the kinds of casualty rate patterns explored in the empirical evidence and revisited here in looking at current rate projections.

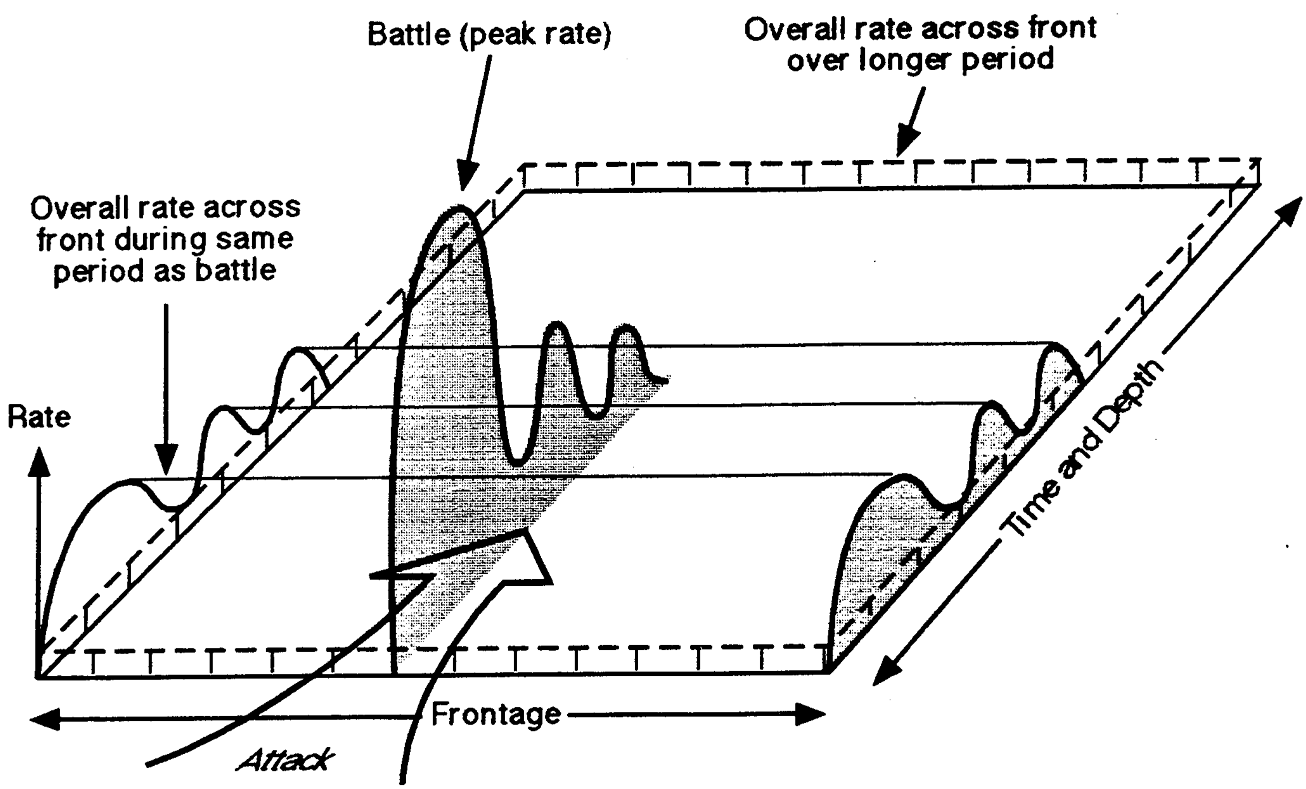

FIG. 2-1. NOTIONAL CASUALTY RATE PATTERN

The figure illustrates the fact that modern operations exhibit pulses of high rates and a variability of rates, which reflect intense combat interactions localized in time and space. The critical issues underlying casualty rates revolve around such questions as how great the magnitudes of pulses and variability may be, how often pulses occur and how long they may last, and generally how combat intensity is distributed across the force.

Our earlier report introduced several approaches to measuring casualty rate pulses and variability. We continue to use those measures in this part of the study. We elaborate on the measures of the quantitative characteristics of rates (using time and location dimensions), and add a new analytic schema that categorizes operational-level scenarios and identifies their major operational phenomena and associated rate magnitudes.

Our analysis, then, addresses both the quantitative characteristics of rate patterns and rates seen more explicitly in terms of their operational settings. The analysis may be divided into rates by time, rates by location, holistic rates, and rates

by operational scenario. The first three describe *underlying quantitative patterns* of casualty rates. The final category describes *patterns of operations* and the rates associated with them.

Rates by Time

The first step in measuring rates in time is to determine how long rate pulses of different magnitudes tend to endure. We use two measures of rate duration. First, we show the number of consecutive days that rates remain in a defined class of rates before dropping to some lower class. Second, we show similar counts, this time of the consecutive days that rates remain in a class before *either* dropping to a lower class *or* rising to a higher one. In both cases, we find that duration is adequately measured by focusing on the single division force size.

Our next measure gauges the relationship of rate magnitude to its variability. The question is how the latter varies as the former varies. We measure the mean-variability relationship by looking at 10-day time periods, finding the mean rate over that period, and determining the variability of daily rates during the period (stated as the standard deviation of the 10 individual daily rates about the mean). Here, we have focused on division, corps, and army force sizes.

A measure of rates in time not included in the first report (although the concept of such a measure is described there) is a look at the shape, as it were, of a rate curve over time. The fact that rates occur in pulses and with variability over time should not obscure the related fact that rates – in the empirical evidence – vary in these ways dramatically and unevenly, not steadily or mechanically. In this report, we also compare empirical rate curves and simulation rate curves by depicting how each describes the curve shape over time, given initial rates of varying magnitude.

Rates by Location

We also compare simulated to empirical rates and patterns in terms of what may be termed their lateral dimension. We do not mean here to refer to the exact lateral deployment of units relative to each other along the front. We refer instead to a force's rates and patterns when the entire force (corps or army) is viewed by day in terms of the separate divisional entities that comprise it. This approach provides a view of the distribution of rates across the front by day according to force size and scenario.

We offer two measures of these distributions. The first looks at the distribution of rates in terms of the *proportion of the force* that falls into different classes of rates by day. One way to see this first measure is to count the number of divisions in each rate class by day; another is to view the force in terms of the percentage of the force's total divisions that fall into those rate classes by day.

The second measure looks at the *distribution of rates* per se across the force by day. This approach orders the force's individual division rates from highest to lowest, and ranks them according to their place in the range (maximum, minimum, median, etc.).

Holistic Rates (Combining Time and Location)

Of course, the two dimensions just described – time and location – must be tied together. Rates must be seen in terms of a full force's experience over a full time period. Such an approach provides a view of the overall average rate for the force and time period and a view as well of the distribution of rates for the full force and time.

We selected two measures: first, the division average rates for the full force (corps or armies) and time period (10 days); second, rate distributions as just described – again, for the full force and full time period – in terms of distributions of rates and proportions of the force.

Rates by Operational Scenario

Finally, we introduce a much fuller view of rates and patterns in terms of the two basic kinds of operational-level scenario: continuous fronts and disrupted fronts. Rates must be understood in terms of the type of operational-level scenario that is being considered in planning and, in particular, in terms of the fundamental operational phenomena that distinguish each scenario type. These scenario types and their characteristic operational phenomena describe patterns of operations which have distinctive rates associated with them.

Probably the fundamental analytic impetus to our study of ground forces casualty rates is the straightforward observation that rates can only be properly evaluated in reference to their operational setting. A tactical casualty rate for a division or corps may certainly be considered on its own terms, but it must ultimately be seen as a rate for such a unit within the broader operational-level scenario of which it is part. Likewise, rates for certain kinds of sectors – e.g., breakthrough

sectors – may be considered as such; but they ultimately make military sense only when set into a complete operational context. It would not be sensible to consider breakthrough sector rates as applying to units in every sector across a frontage far broader than any breakthrough sector would possibly occupy.

Our research into the empirical evidence of modern casualty rates and into the continuing forms and patterns of modern operations has uncovered what we believe may be an overall structure of operational-level operations. Such operations fall not only into the two general categories of continuous and disrupted fronts, but may be described in terms of the kinds of major combat events that comprise them. Certain rates characterize each type of operation across a spectrum. This report attempts to describe this framework of operations types in at least general terms.

OTHER METHODOLOGICAL NOTES

We focus our analysis on projected battle casualty rates and patterns as such. We offer only general comments on supporting methodologies (especially in Chapter 7) when they seem appropriate to help account for the projected rates.[6]

Each of the planning rate projections is assessed against empirically established rate standards that our research indicates are appropriate for certain force sizes, time periods, and general scenarios. The proportions of attention paid to the different planning projections, however, differ considerably. Those differences are due both to the nature of the projections themselves and to the broader purpose of this second report.

The different planning projections analyzed here afford not only different degrees of detail but different perspectives as well. Some – such as the rate projection processes used by the U.S. Army Staff and the FRG – offer relatively full rate detail. Others – such as the processes used by the U.S. combatant commands and the U.S. Marine Corps – basically afford only sets of isolated rate numbers assigned by planners to describe the planning force for certain time periods and settings.

[6]While we spent considerable effort on clarifying the several methodologies, we do not present a detailed critique of them here. We believe it is too often assumed that the reasonableness of a process is an adequate measure of the reasonableness of results – even when great uncertainty surrounds the character of the variables involved and the character of the cause-effect relationships among these variables. Focus on process is necessary to ensure the casualty estimates are reasonable. However, ultimately, only a focus on the reasonableness of the estimates themselves – hence, on measures of reasonableness – promises a means to meet the fundamental planning responsibility.

Similarly, some projections take the perspective of an army-size force while others apply only to particular corps or even single divisions. All the planning projections referred to in Chapter 1 are assessed, but the assessments are made in keeping with the available detail and perspectives.

We must also keep in mind the role of this second report in the three-report series. It is largely intended as a companion piece to our first research report. Together, they develop our analysis of the kinds of rates and patterns associated with major conventional war scenarios.[7] Certain of the planning projections afford the combined perspective and detail that better suit our requirement to analyze these rates and patterns.

The great majority of effort in this unclassified portion of the report is spent considering the U.S. Army Staff's campaign simulation results and in developing a fuller view of the types of operational-level scenarios and their rates. The classified section is limited to a briefer review of the various actual estimates in light of the detailed insights into rates and patterns developed in both our first and this second report.

Four final notes may be useful.

First, in this report, we focus on total battle casualties (TBC) per 1000 division-level personnel per day. TBCs include all killed, wounded,[8] and missing-captured.[9]

Second, we define tactical rates as rates for single divisions and for corps (the latter for periods at least up to 5 days). Forces representing the operational level of

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[7]The third report will use these insights to propose a set of rate ranges and patterns that planners may use to build more militarily realistic battle casualty rate projections given certain force sizes, time periods, and broad scenarios.

[8]A question arose following our first report as to whether our World War II U.S. data include what the United States terms "wounded nonadmission" casualties (i.e., "carded for record only" (CRO) casualties). The U.S. definition for CRO casualties has generally been those wounded who are returned to duty within 72 hours. Our U.S. data include all wounded absent from their unit's control for more than 24 hours. We are not yet aware of a database that shows the proportions of such casualties that return to duty on each of the 3 days. Our U.S. data may therefore include two-thirds, or half, or some other proportion of CRO casualties.

[9]We showed in the first report how rates for wounded-in-action (WIA) casualties are a fairly stable proportion (70 to 80 percent) of TBCs in offensive scenarios but can drop significantly (to ≤ 30 percent) during worst-case continuous front defensives and during disrupted front scenarios. In this report, we do not dwell on WIA measures per se but will return in the final report to specify WIA as well as killed and missing-captured as parts of the TBC rate.

war are defined to start at least with army-sized formations for periods of at least 10 days.[10]

Third, we discuss rates at different places in the report in terms of either single divisions, corps, and/or armies. Several considerations must be kept clear when specifying rates for these forces. Most generally, corps and army forces are defined in terms of the numbers of divisions (and division-equivalent maneuver forces) comprising them. ("Divisions" generally range in size from about 10,000 to 18,000 personnel.) A corps-size force is considered to be one of from 2 to 6 divisions. An army-size force ranges from 10 to 15 divisions usually, but may also include as few as 8 and as many as 22 divisions.

When discussing corps and army rates, we usually focus on the casualty rate for assigned divisions. We do not specify rates for nondivisional units or strength, or rates for the full echelon (including both divisional and nondivisional strength). Such rates would in all cases be lower than the rates we discuss.

Wherever possible we use *assigned* (on-hand) strength as the measure of strength.[11] Our main reason for using assigned rather than authorized strength lies in the fact the empirical data are nearly always stated in such terms. Proper comparisons of rates depend on comparing like values.[12]

The latter thought points to a final consideration. We discuss at length (especially in Chapters 4 and 6) one set of results from the Army Staff's theater-level simulation. That simulation has of course been run many times over the years to produce rate projections for the Army Staff's planning needs. Those sets of results are not identical. We dwell on one set of results in part because collecting sufficient data on the others was impractical, but more so because we believe that set is adequately

[10]The designation of a corps-size force as a tactical force for the sake of rate determination should not be confused with the fact such a force can perform an operational-level mission.

[11]Neither our empirical data nor the planning data studied specify returns-to-duty or replacements as separate components of daily strength. However, in both cases these numbers are included in daily counts of assigned strength.

[12]A major result of our choice to use assigned strengths is that certain planning rates must be reconsidered in that light. For example, the U.S. Army Staff uses average authorized strengths as the basis for calculating projected casualty rates. We were required to devise a way to recast the Army's simulation results in terms of assigned strengths in order to make the proper comparison with the empirical data. In other words, any planning rate that uses authorized strengths (for example, assuming the full authorized strength as the average strength over a multiday period) must be taken to be lower than a rate rendered truly comparable to the empirical data.

representative of the character of the simulation's results. Different runs produce different numbers, but the uniformity evident in the simulation's rate patterns is characteristic.

CHAPTER 3

THE BASIS OF THE ARMY STAFF'S PERSONNEL BATTLE CASUALTY RATE PROJECTIONS

GENERAL

Since 1980, the U.S. Army has relied on a campaign-level mathematical simulation to project the divisional battle casualty rates that support Army Staff planning for personnel and medical force structure requirements.[1] The Concepts Evaluation Model (CEM) remains, as of this writing, the official source of these Army casualty rates.[2]

Our analysis aims to compare the character of this simulation's casualty rate results with the character of empirical casualty rates. We focus on one major run of the CEM simulation, termed "Omnibus 89." Our interest is not directed at that particular run per se but rather at the set of results as representative of the character of casualty rate results produced generally by the simulation. At a further remove, it is probable that these results are at least indicative of the character of casualty rate results in mathematical simulations more generally.

Our question is whether the character of the patterns and rates of simulated casualties reasonably well reflects the kinds of patterns and rates to be expected in the setting depicted: a theater-level conflict between NATO and Warsaw Pact forces. We examine this issue both in terms of the simulation's representation of the U.S. force experience and more broadly in terms of its representation of the overall NATO defending force.

The detailed comparisons in Chapter 4 rest on Omnibus 89 data and data taken from the U.S. Army's operations in Northwest Europe in 1944-45. The latter

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[1]Battle casualty rates for personnel strictly assigned to corps and communications zone (COMMZ) units are derived from historical experience modified upward by an unknown method.

[2]A follow-on model, the Force Evaluation Model (FORCEM), is apparently nearing the point at which it will become the primary source of rates. FORCEM's output – indeed, the output of any ground forces campaign model, especially where daily results are available – can be evaluated using the same analytic comparisons with the body of empirical data on casualty rates and patterns as undertaken in Chapters 4 and 6 on CEM output.

experience includes one major scenario – the Ardennes defensive – that is similar operationally to known planning scenarios in which NATO forces withstand a major offensive and are pushed back but not broken. We then make more general comparisons in Chapter 6 between the simulation's output rates and a spectrum of operational-level rates we now find is associated with a spectrum of operational-level scenarios. Many of those operational-level rates are German rates seen against Soviet forces and methods on the Eastern Front, and most of them represent scenarios distinctly different from U.S. and NATO planning scenarios.

ARMY STAFF CASUALTY RATE GENERATION PROCESS

The CAA maintains a complex mathematical modeling process by which war in different geographic regions may be simulated. Originally, that modeling process was intended to enable the Army Staff to compare the relative effectiveness and requirements (e.g., for ammunition and fuel consumption, for replacing equipment losses, etc.) of forces using different generations and combinations of major types of crew-served weaponry and other major systems. Around 1980, this theater-level simulation process was amended to add the capability to provide projections of personnel casualties. Various simulations of possible theater conflicts since then have been the basis of the Army's POM process for personnel and medical (and related) requirements and likewise the basis of personnel planning requirements in the DoD Wartime Manpower Planning System (WARMAPS).

The CAA usually conducts at least two major analyses of Army force requirements each year. One series – the Omnibus series – looks at conflict results and U.S. requirements assuming the currently fielded force engages the threat. A second series looks at results and requirements assuming instead a planned force (usually some 6 to 7 years in the future) that has had the benefit of full funding of the POM.[3] The first study type is termed a "capability" study; the second, a "requirements" study.

The ARSTAF uses various of these capabilities and requirements studies as sources of its annual planning for the "near year" (the first year) and the "far year"

[3]The second series is usually termed an SRA (Support Requirements Analysis) or TAA (Total Army Analysis) study. In some years, the role of this future-looking study may also be played by other studies, such as the PFCA (Program Force Capability Analysis) series.

(the last year) of the POM cycle. The source of a particular near year or far year rate projection may be either a capability or a requirements study.

Figure 3-1 shows near year and/or far year rate curves for four annual cycles of projected casualty rates for U.S. divisional forces in a NATO-Warsaw Pact conflict. All these projections assume the same broad scenario, which portrays U.S. forces as heavily pressed early in the conflict.

LMI "OMNIBUS 89" DATABASE

LMI received from CAA a copy of the first 60 days' results of the Omnibus 89 run of the CAA modeling process (using CEM) depicting a NATO-Warsaw Pact conflict. The CAA data revealed daily personnel strength and casualty results for all U.S. and Allied units (as well as for Warsaw Pact forces). We then transformed the data into a format comparable to the format of the World War II data previously collected on forces engaged over tactical and operational-level time periods and frontages.

The CEM model represents a theater campaign by depicting – in this case, on the NATO side – brigade-sized combat units in 12-hour cycles. The simulation represents only the "fighter" elements of the force, mainly the crews of major crew-served weapon systems. Support and other personnel are not represented. Finally, the model simulates almost exclusively divisional fighter personnel, rather than combat personnel from higher echelons.

Our analytic approach focuses on casualty rates measured by casualties per 1000 division-level personnel per day. We look at these rates in terms of either individual divisions or the typical aggregates of divisions in corps or armies.[4] We needed to be able to see the simulation's output in terms of division casualty rates,

[4]Our empirical data also permit looks at corps and army rates when considering all non-divisional combat and support/administrative personnel up to army or even army group level – or, simply, looks at the rates specifically for those personnel. We did not perform those analyses mainly because they would have detracted from the effort necessary to complete our principal analysis of overall divisional battle casualty rates. We are also less certain of the direct relevance of World War II data for gauging combat casualty rates for ground forces personnel the deeper they are located in rear areas. Whatever that relevance may be, even a 10-fold increase in that war's casualty numbers for U.S. rear area personnel would still show that ground forces combat casualty rates are overwhelmingly focused among divisional personnel. The only significant reduction of this dominance of divisional personnel casualties that appears realistically conceivable would depend on a major change of operational scenarios from a continuous front setting to one of the (probably higher-order) disrupted fronts. (See Chapter 5 for a description of these disrupted fronts.)

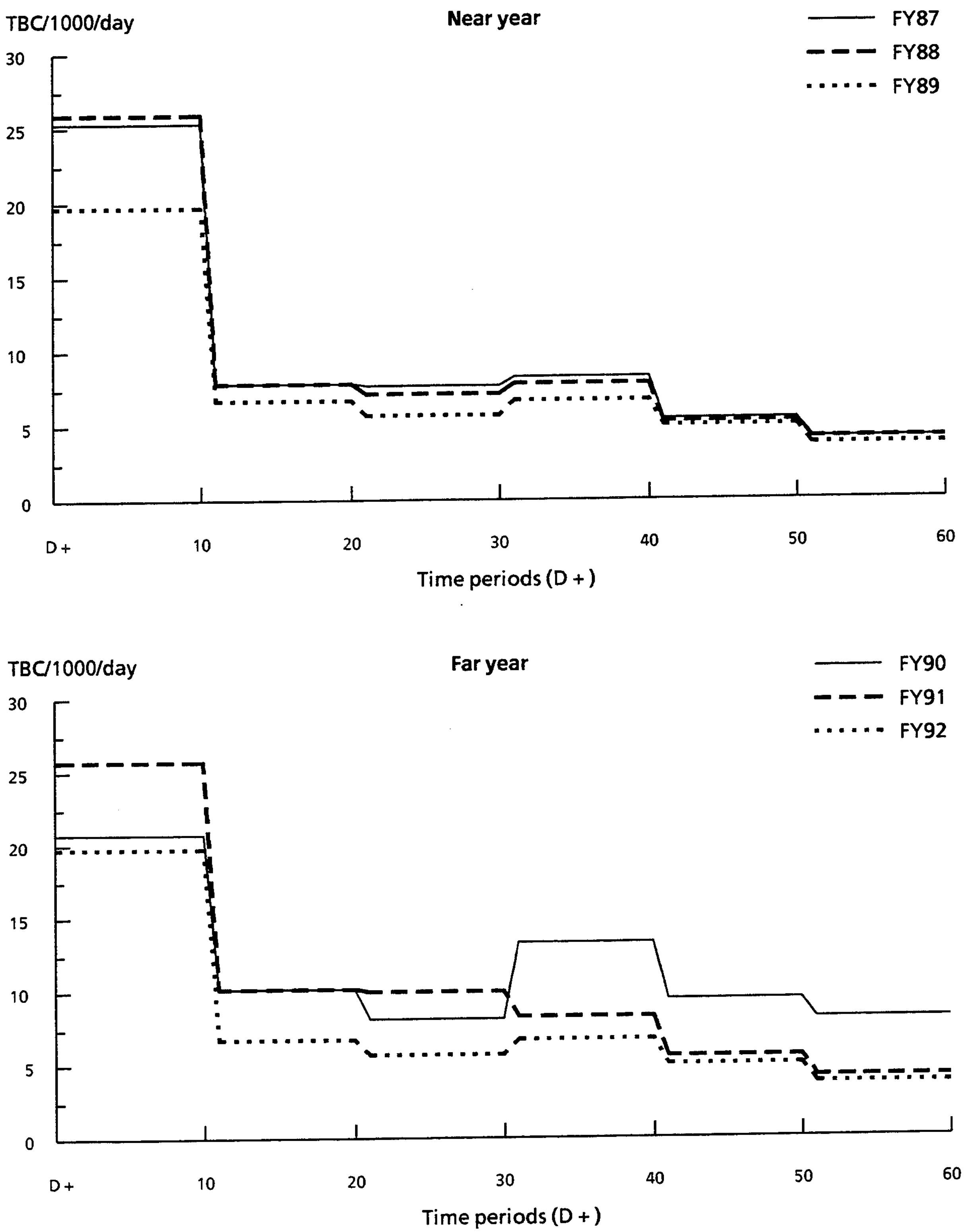

FIG. 3-1. WARMAPS PROJECTED DIVISIONAL TBC RATES

(Near year and far year – TBC/1000/day)

and in terms of the various aggregates of division-level rates across the full set of corps and armies represented. Thus, the simulation's brigade "fighter" casualty results on a twice-daily basis needed to be transformed into daily division casualty results, division-level assigned (on-hand) strengths by day were needed, and divisions needed to be tied each day to their chains of command up to army – in NATO parlance, "army group" – level.

With vital assistance in several particulars from the CAA staff, we transformed the Omnibus 89 data into a generalized format. For each division (U.S., Allied, or Warsaw Pact) for each day, the format included the division's type and coded (unclassified) number, its authorized and assigned ("on-hand") strengths,[5] its total "fighter casualties," its TBCs (including support casualties),[6] its posture or mission (e.g., attack, defense, reserve), and the location along the forward line of own troops (FLOT) of its left and right flanks (which therein showed its frontage in kilometers and its lateral relationship to other divisions across both sides of the front).

Thus formatted, we were able to make accurate comparisons between the simulation's representation of both tactical and operational-level casualty rates and patterns and the patterns of rates seen in the collected empirical data.

[5]We calculated the division-level daily assigned strength by assuming that each division's assigned strength equated its authorized strength on the first day of its appearance, and then using an algorithm that took the previous day's strength, subtracted the day's casualties, and added the replacements/returns-to-duty per division which were evident (in the NATO brigade data or Warsaw Pact division data and assuming the proportion of support casualties replaced to equal the proportion of fighter casualties replaced) in the output received from CAA. As an added measure of conservatism, we increased the support strength of those nine Allied divisions that, in the data on initial authorized division strengths provided us by CAA, had low support strength, so that the new ratio of these divisions' initial support and fighter strengths equaled the normal U.S. division's initial ratio. Likewise, some of the U.S. "divisions" in the model were in fact only aggregates of two or three separate brigades or regiments; we increased these divisions' strength so the U.S. fighter-support ratio was maintained. These actions resulted in all NATO divisions being as large or larger than U.S. divisions (and in the U.S. brigade-divisions causing no upward bias in U.S. rates because of their smaller size). Warsaw Pact division initial strengths were accepted at the level provided us by CAA.

[6]For U.S. divisions, we used the CAA method of multiplying the division's "fighter" casualties by 1.208 to produce an overall division casualty number that accounts for both fighter and support casualties. Each non-U.S. Allied division and Warsaw Pact division's fighter casualties were multiplied by a number that assumed a casualty rate among support personnel for that division that was equivalent, given the division's actual support-to-fighter strength provided to us by CAA, to the rate among support personnel CAA assumes for U.S. divisions. (This procedure – when taken in combination with LMI's increasing of the numbers of support personnel for those nine Allied divisions that had low levels of support personnel relative to U.S. and most other Allied divisions – acted to understate these nine divisions' casualty rates still further than noted in Footnote 5.)

CHAPTER 4

UNDERLYING QUANTITATIVE PATTERNS OF CASUALTY RATES IN THE U.S. ARMY OPERATIONAL-LEVEL MATHEMATICAL SIMULATION

GENERAL

This chapter details our comparisons of the quantitative characteristics of Omnibus 89's casualty rate output with the quantitative characteristics of rate patterns found in empirical evidence. Our analysis addresses these rate characteristics from three perspectives: the time dimension; the lateral dimension; and a combination of the two in a fuller, holistic view.[1] (We also take note of rates in terms of force posture.) We examine relative rates and patterns at the division, corps, and army echelons. In Chapter 5, we discuss rates and patterns in terms of the major operational phenomena – the patterns of operations – our research now indicates are associated with rates in operational-level scenarios.

In this chapter, we focus principally on underlying rate patterns and afford only secondary interest to the rate magnitudes per se. While rate magnitude is, of course, at issue throughout the analysis, it is more appropriately addressed in terms of scenarios.

THE KINDS OF RATES AT ISSUE

We first display curves of daily casualty rate experience as seen in simulation and empirical data. Figures 4-1 through 4-3 illustrate three pairs of rate curves representative of the two (empirical and simulated) sets of rate experiences at the division, corps, and army levels.

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[1]While we attempt here to look separately at these dimensions to bring order to the discussion, we cannot entirely separate them. Further, casualty rates (and their dimensional measures) provide only partial views of the phenomenon itself which is reflected in them. The phenomenon is, of course, the combat operation – its character or shape – as described or represented by casualty rates. While this point seems obvious, the analytic community appears at least sometimes to speak of casualty rates as though they somehow had independent status as phenomena rather than being merely potentially consistent measures of it. That erroneous notion may help explain why inappropriate comparisons are often made between rates arising from different force sizes, time periods, and settings.

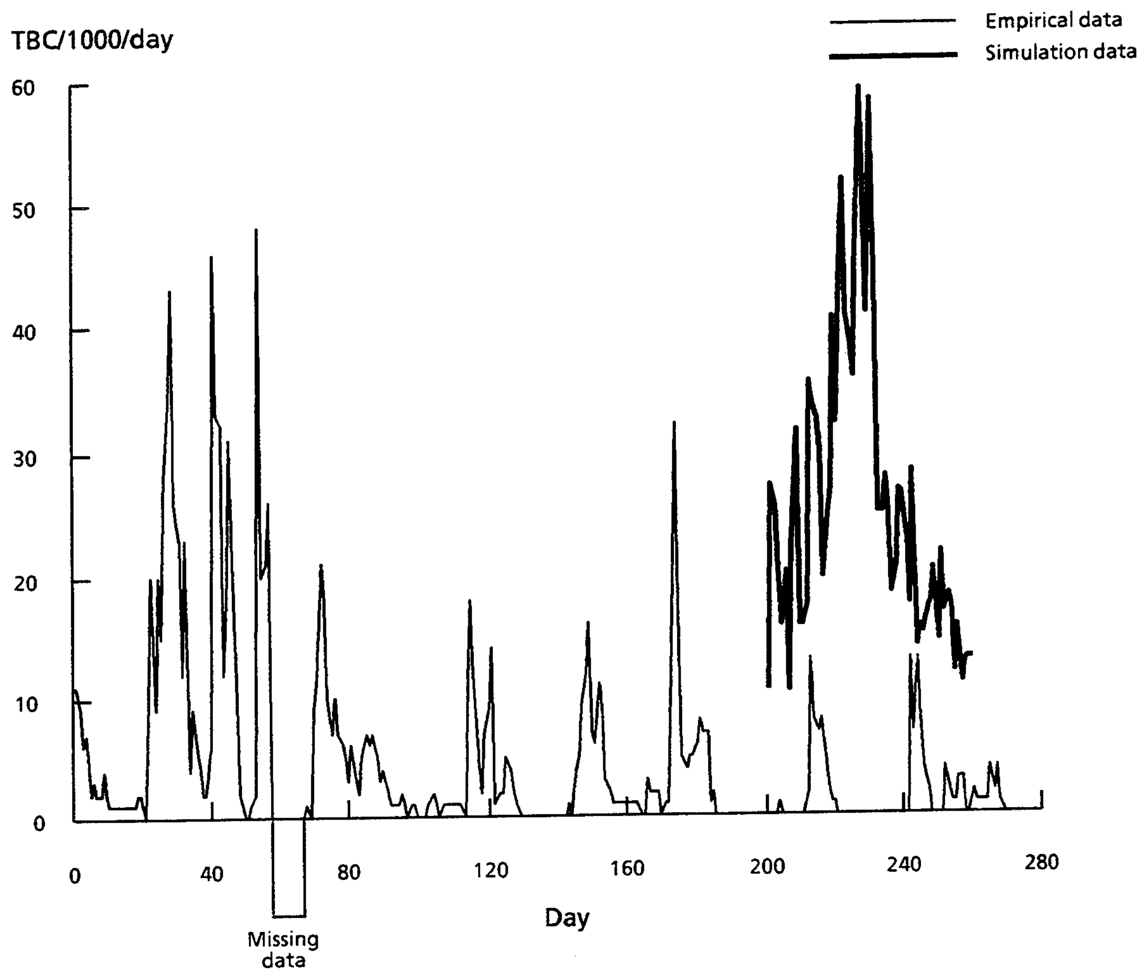

FIG. 4-1. SIMULATION VERSUS EMPIRICAL EVIDENCE OF DAILY TBC RATE FOR SINGLE DIVISION

The clear difference between the simulation and empirical data gave rise to our concern that, even if we were inclined on the face of it to accept simulated rates as realistic, the *patterns* of the simulated rates would raise serious doubts about the adequacy of the simulation's representation of combat phenomena.

CASUALTY RATE PATTERNS IN TIME

We examine three measures of the simulation's representation of casualty rates over time. The first test measures the duration (in consecutive days) of the casualty rates of single NATO divisions in defined classes of rates. The empirical evidence is clear that the higher a division's casualty rate, the fewer days it is likely to persist at that level before falling. The second test measures the relationship between a mean

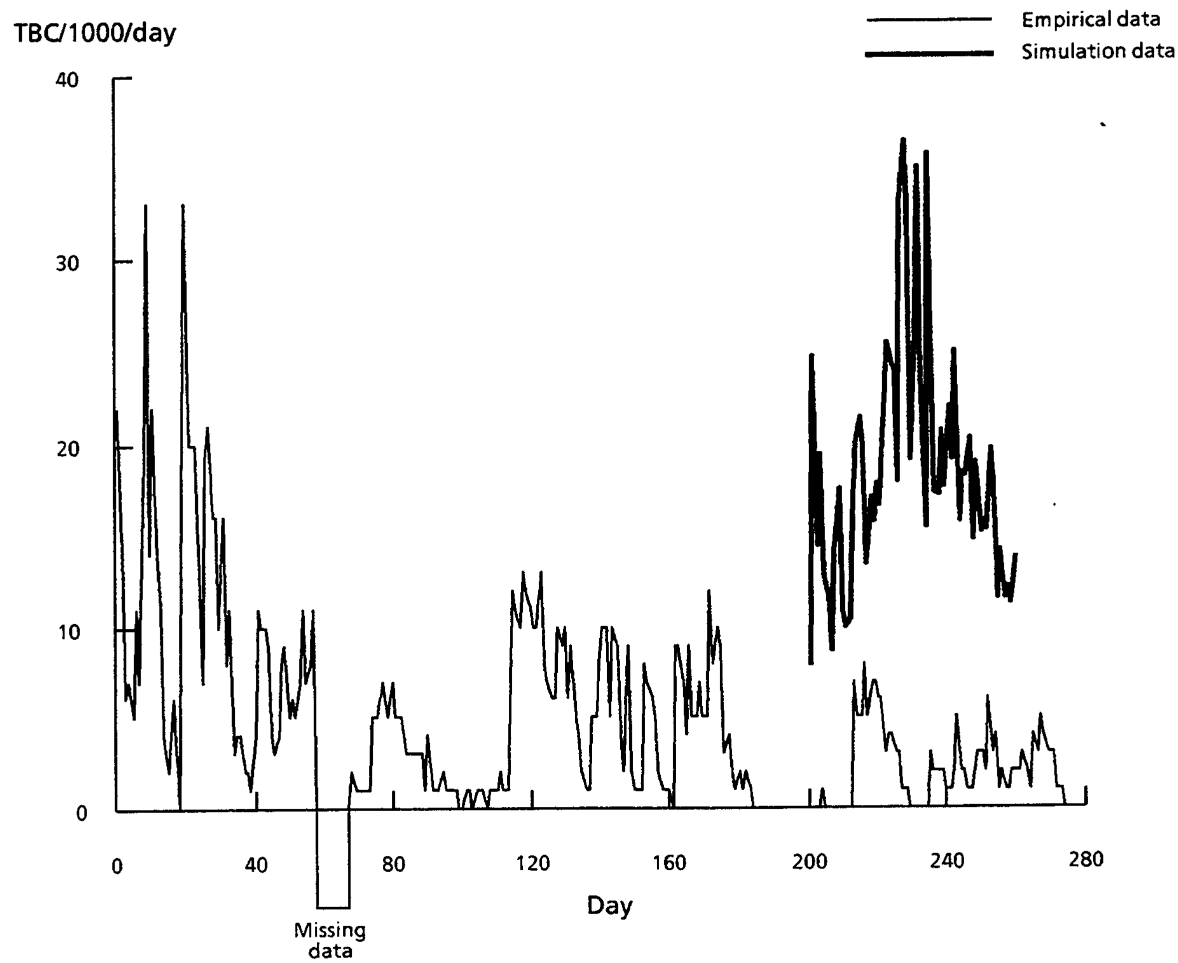

FIG. 4-2. SIMULATION VERSUS EMPIRICAL EVIDENCE OF DAILY TBC RATE FOR SINGLE CORPS

casualty rate over a 10-day period and the variability of the 10 individual daily rates about that mean rate. Again, the empirical evidence is clear that as the mean rate increases, the variability of daily rates also increases during the period. The third test addresses the shape of the time series casualty rate curves, looking for congruence with the empirically established pattern of high rates (pulses) being followed by generally significantly lower average rates.[2]

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[2]Of course, these rate pulses are also preceded by periods of lower average rates. Our analysis of rate curve shape begins with a pulse on a given day, x, without regard to previous days.

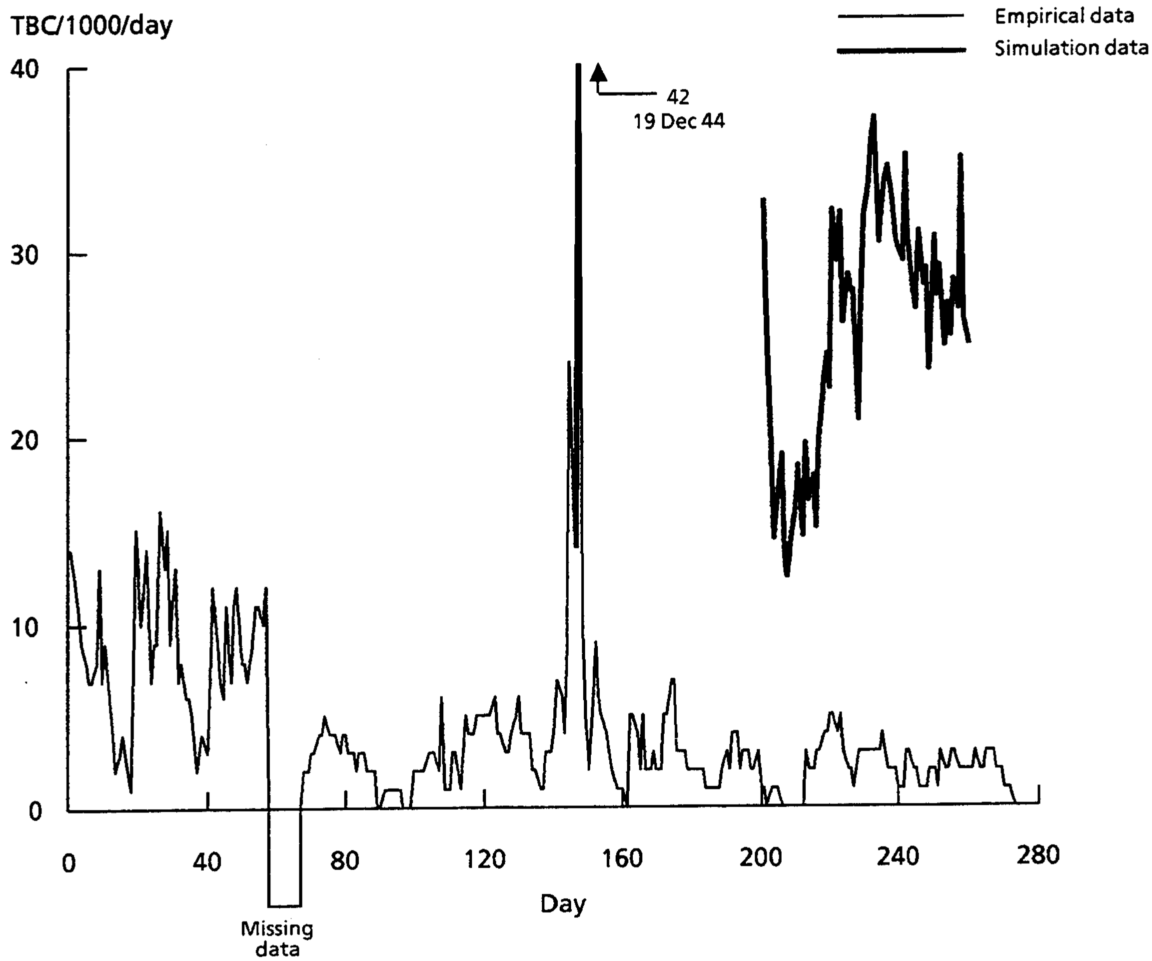
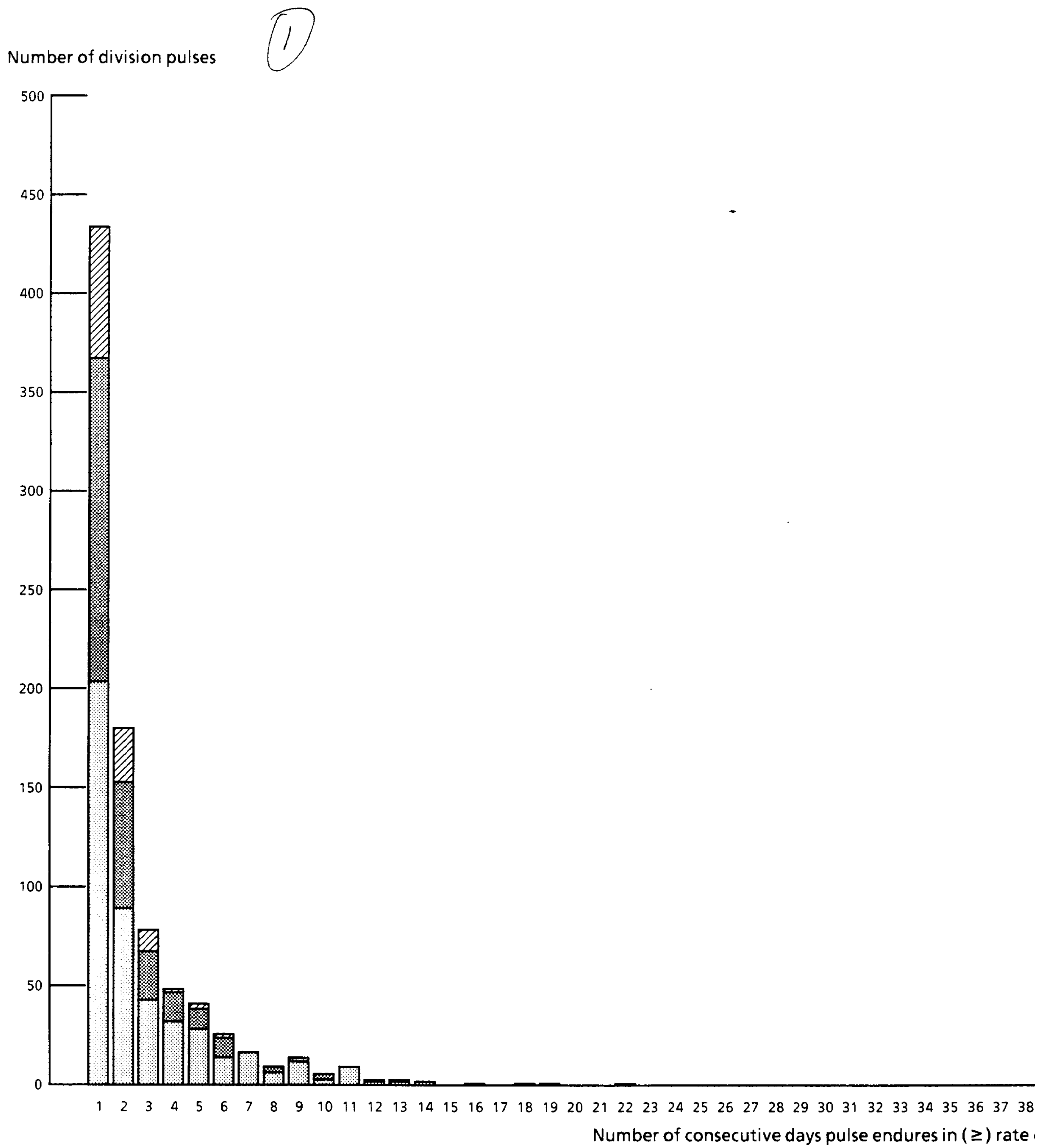


FIG. 4-3. SIMULATION VERSUS EMPIRICAL EVIDENCE OF DAILY TBC RATE FOR SINGLE ARMY

Comparisons of Rate Duration Measures

Figures 4-4 and 4-5 present a first view of the results of the first test comparison: how long do rates last at a certain level (or higher) before falling to some lower class of rates? The contrast between the two sets of divisions is stark. The simulated divisions have a tendency that is precisely the reverse of that of actual divisions. Where an actual division's high rates tend to endure only briefly (a day or two), a simulated division is as likely or more likely to exhibit many (say, up to 20 or even 36) days at a high rate as at a lower rate. The figures also suggest that where the actual division is less likely to experience a high rate than a lower one, the simulated division is more likely to experience high rates.



(1)
Number of division pulses
500
450
400
350
300
250
200
150
100
50
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
Number of consecutive days pulse endures in (≥) rate

2

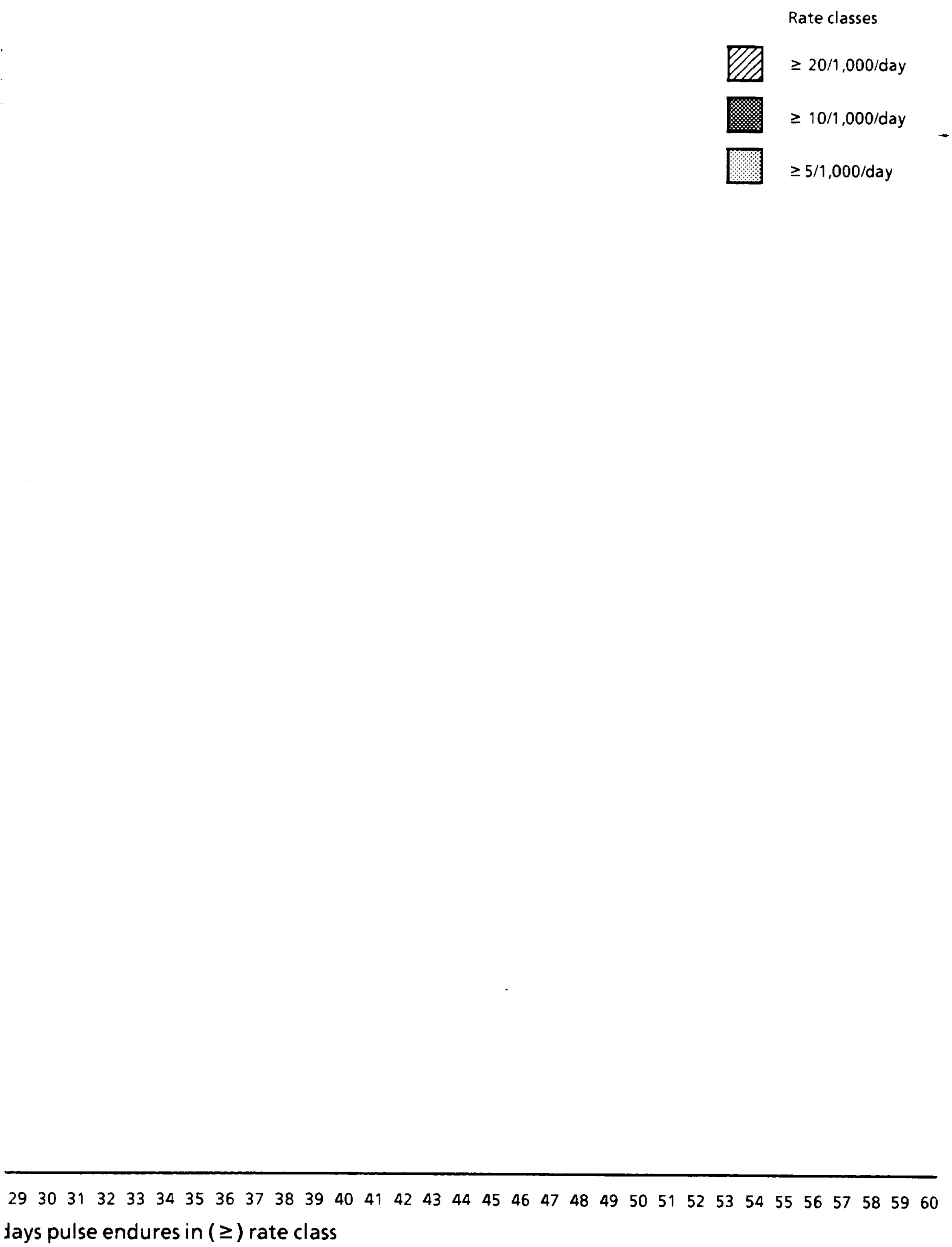
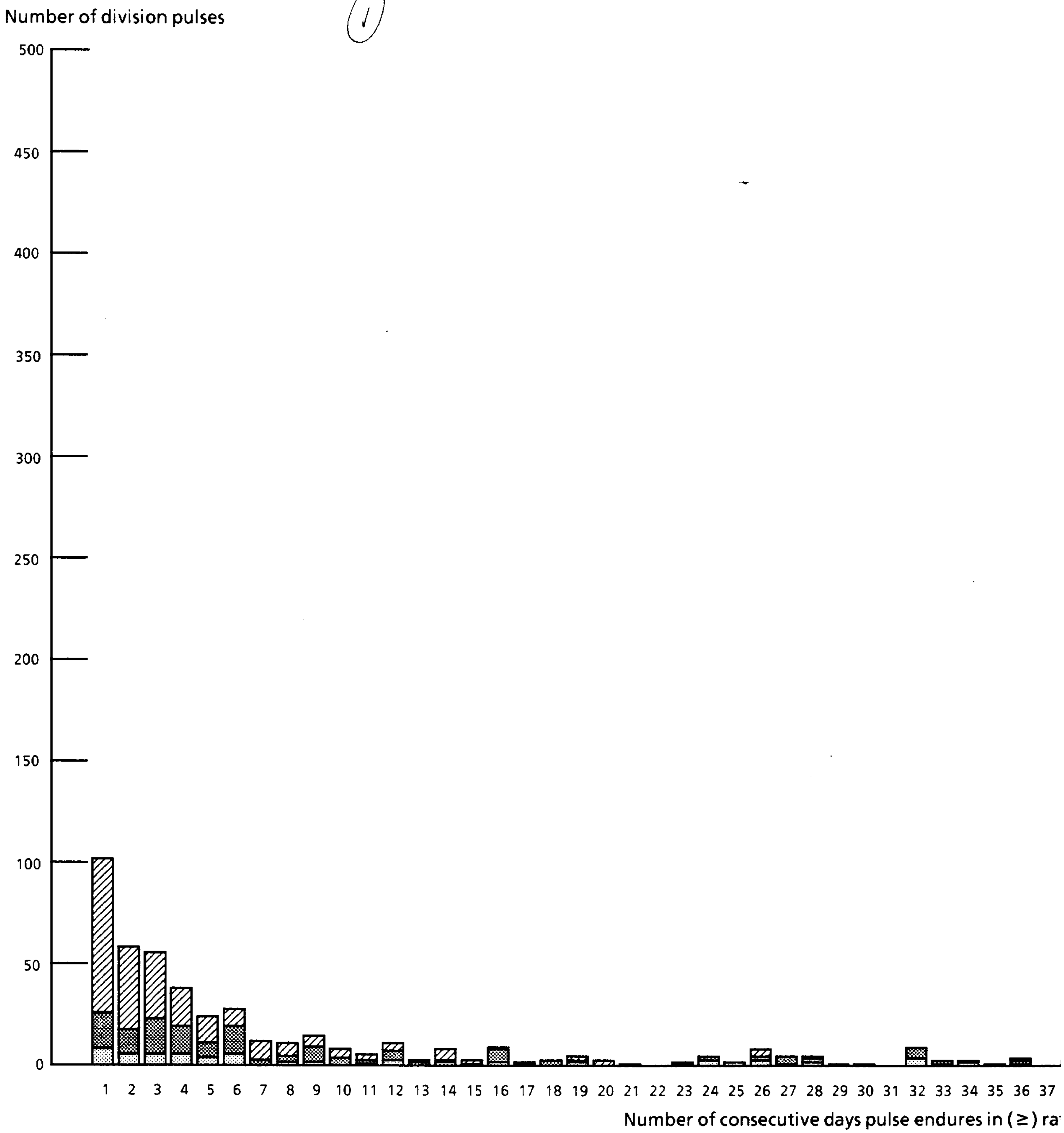


FIG. 4-4. DURATION OF DIVISION PULSES BY (≥) RATE CLASS – EMPIRICAL EVIDENCE



Number of division pulses
500
450
400
350
300
250
200
150
100
50
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37
Number of consecutive days pulse endures in (≥) ra

2

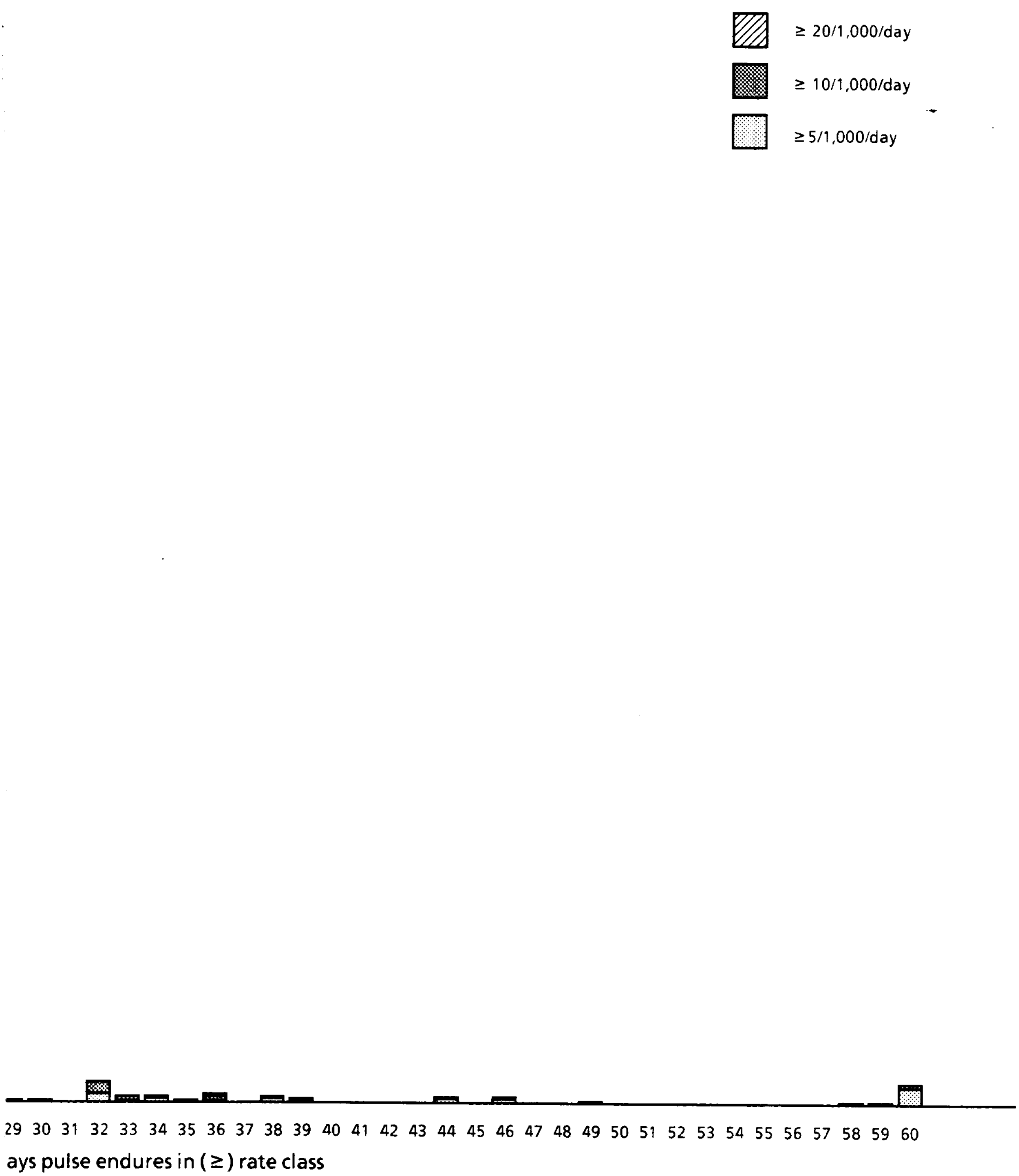


FIG. 4-5. DURATION OF DIVISION PULSES BY (≥) RATE CLASS – SIMULATION

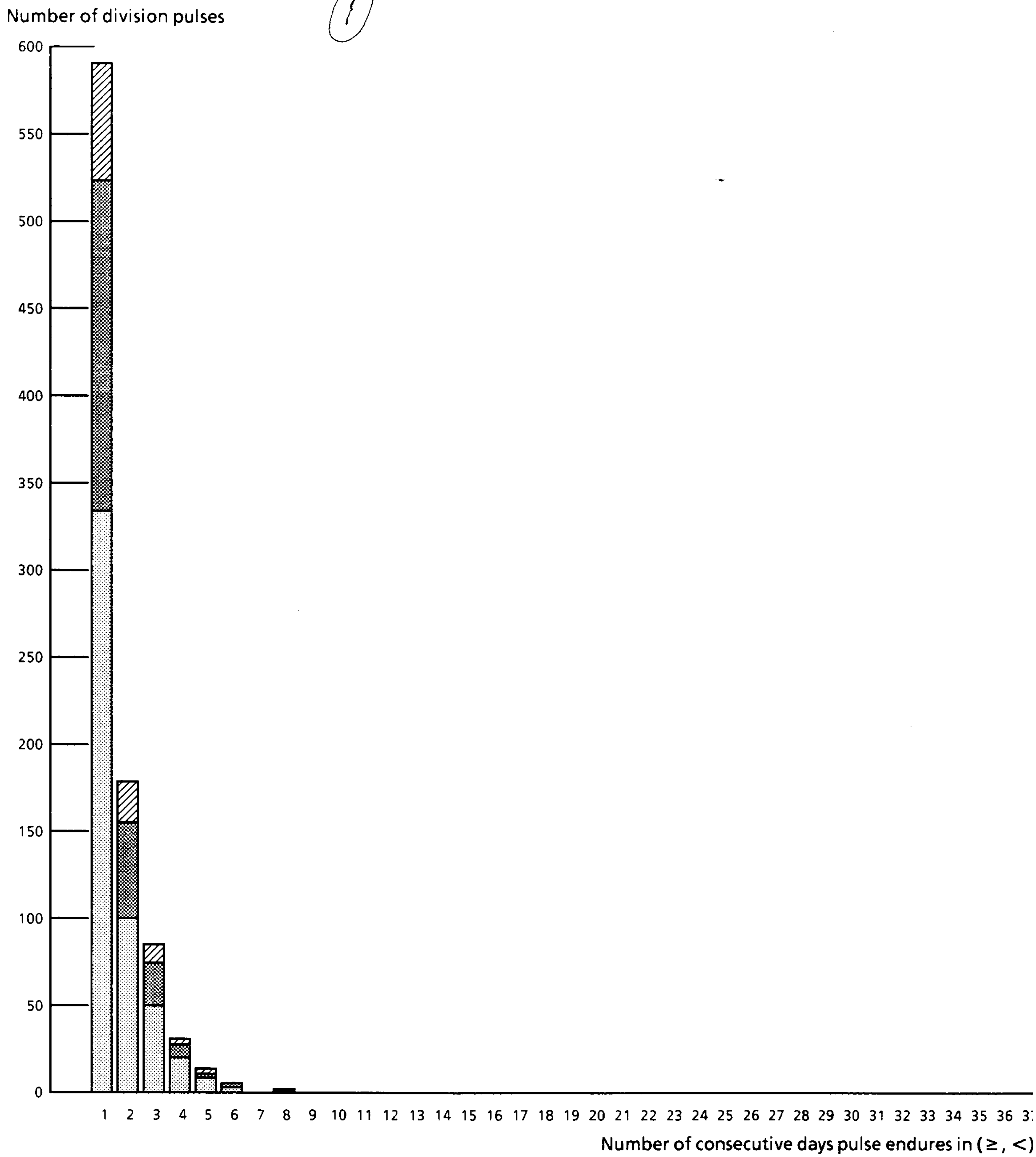
A second way to compare the rate durations of actual and simulated divisions is to measure how long a division's casualty rate persists in a single class of rates before *either* falling to a lower class *or* rising to a higher one. This measure focuses on both the variability of rates and on where rates tend to "reside" in terms of the rate classes. Figures 4-6 and 4-7 show the results of this second rate duration test measure.

The longest duration seen for a simulated division in the lowest rate class (of 5-to-10/1000/day) is 11 days. Only one case each of this rate is maintained for 11 days or even for only 6 or 7 days. The clear tendency for a simulated division with its rate in this lowest class is to remain at this level for periods of 1 or 2 days – a tendency that corresponds only to real divisions' likelihood of remaining in the highest of the three rate classes.

To be sure, the simulation parallels empirical experience in showing many fewer cases of long-enduring rates than of rates more briefly experienced. The simulation, that is, does depict variation in rates over time – the subject of our next test. The problem is that the longest durations of rates seen in the simulation are exclusively in the highest rate class (of ≥ 20/1000/day), and the durations seen here are as long as 36 days. The empirical data clearly show, even for lesser rates in the range of 10-to-20/1000/day, that 10 days is a long time in real combat. To maintain even these lower rates consecutively for as long as 10 days is nearly without precedent.[3]

Figure 4-8 provides another perspective on this first major contrast between rate durations in the simulation's portrayal of casualty rate experience and the experience of actual divisions. The figure shows the empirical and simulation data sets' contrasting percentages of total duration observations falling into each rate class category (using the first measure as shown in Figures 4-4 and 4-5). The simulation simply reverses the empirical experience.

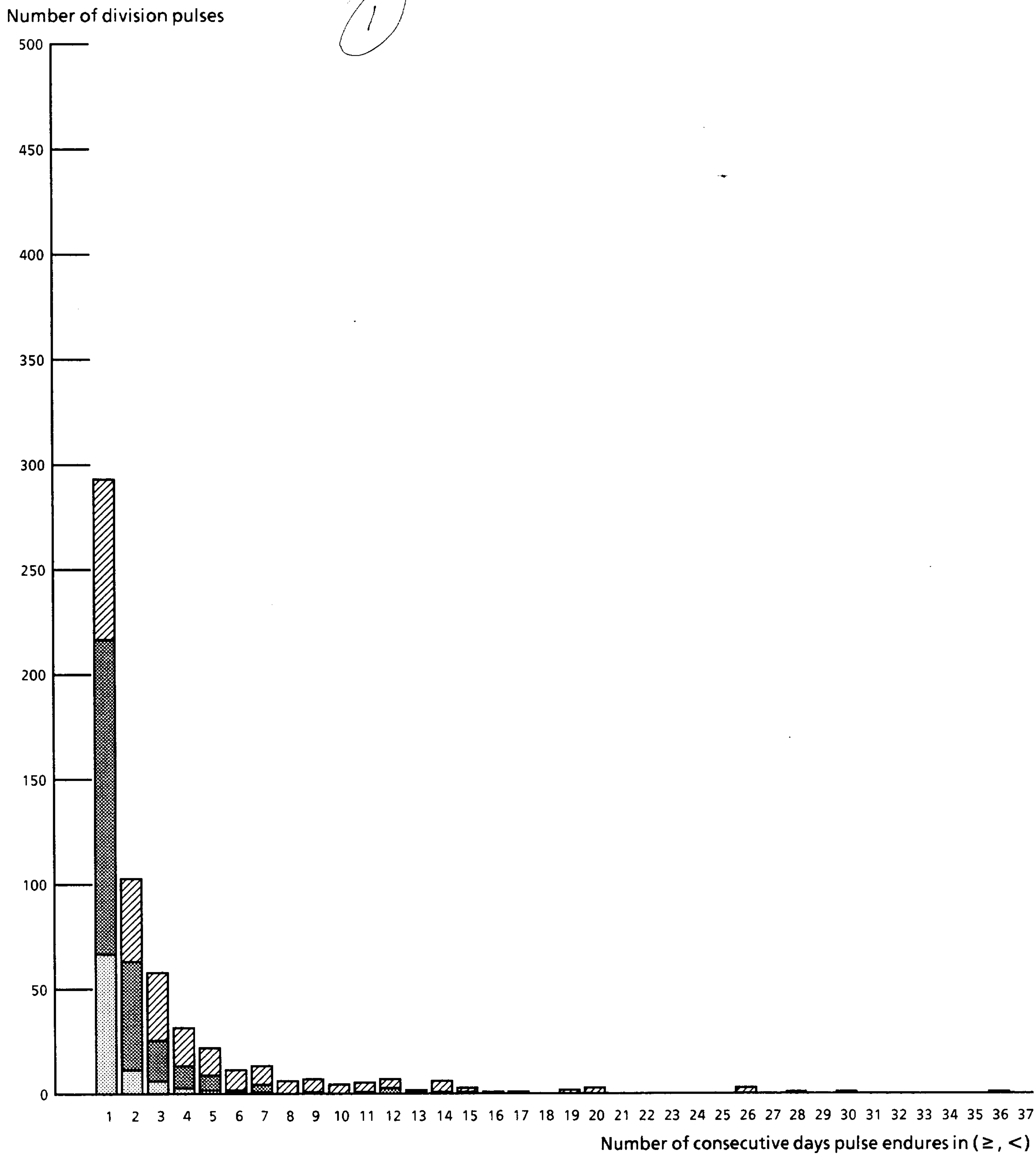
[3]We noted in the earlier report that U.S. Marine Corps experience in a few World War II Pacific island operations (such as that at Iwo Jima) was marked by a moderately high, relatively steady attrition over a number of weeks. The rates were not exceptional on any given day (though they sometimes reached into the range of 40/1000/day). Instead, these operations were famed for heavy attrition because of the relative steadiness of the daily rates over relatively extended periods. The simulation's rates are probably more similar to these rates in terms of rate duration than to any rates for modern conventional (usually mobile) operations of which we are aware.



Number of division pulses
600
550
500
450
400
350
300
250
200
150
100
50
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37
Number of consecutive days pulse endures in (≥, <)

2

FIG. 4-6. DURATION OF DIVISION PULSES BY (≥, <) RATE CLASS – EMPIRICAL EVIDENCE



Number of division pulses
500
450
400
350
300
250
200
150
100
50
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37
Number of consecutive days pulse endures in (≥ , <)

2

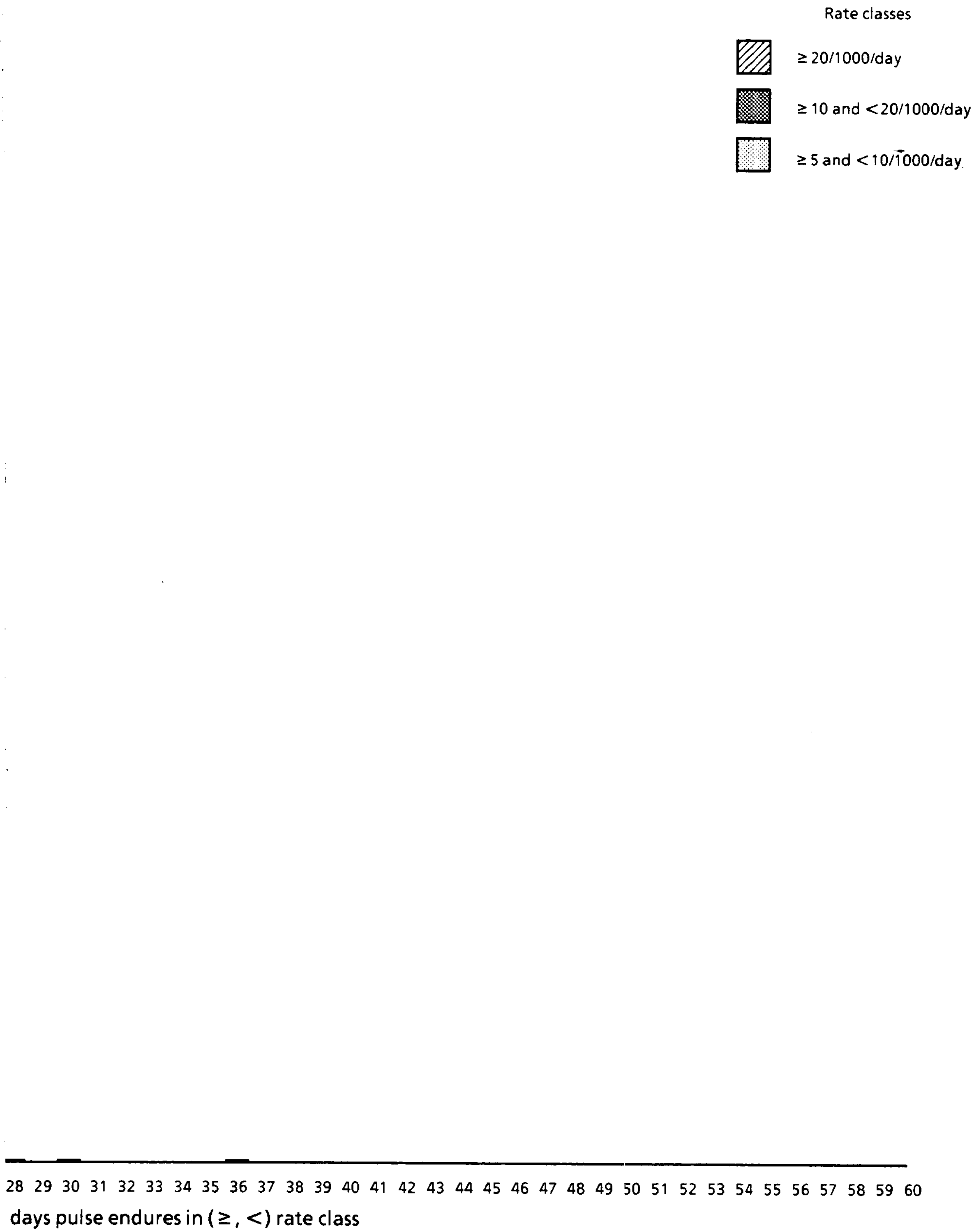


FIG. 4-7. DURATION OF DIVISION PULSES BY (≥, <) RATE CLASS – SIMULATION

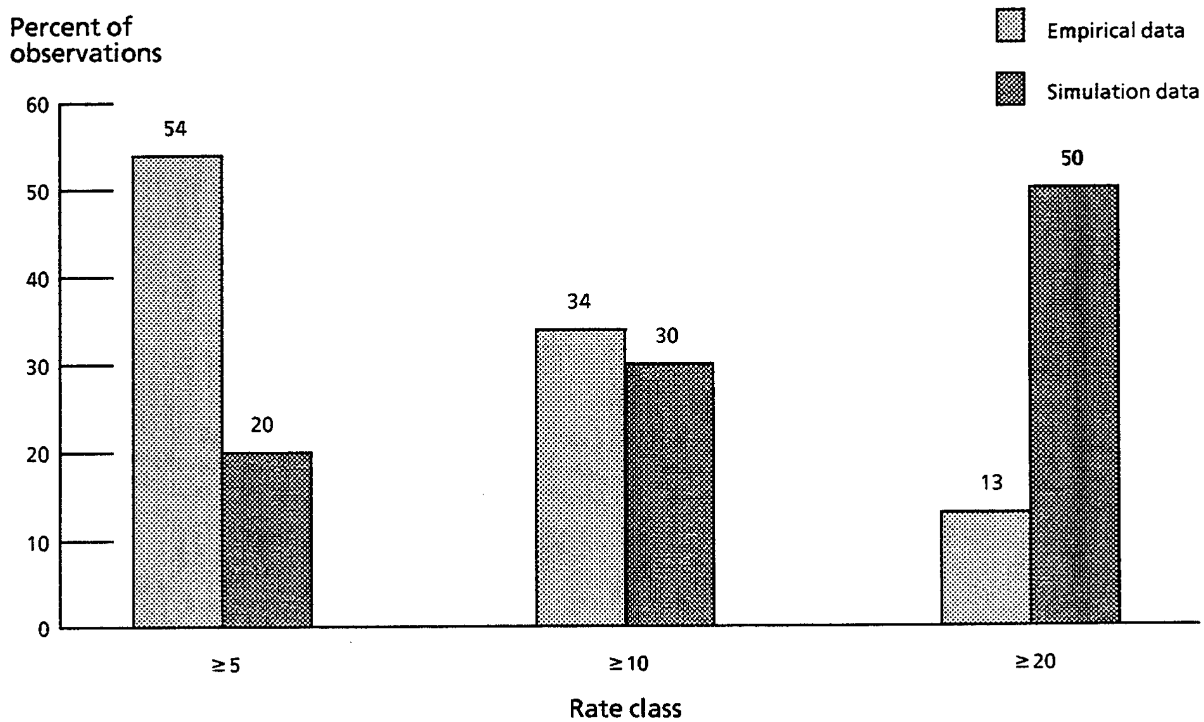


FIG. 4-8. PERCENTAGE OF DIVISION "DURATION" (≥) OBSERVATIONS BY RATE CLASS

Comparisons of Rate Mean-Variability Relationships and Rate Curve Shapes

Our next major test was to check the model's representation of the relationship between an average casualty rate over a given time period and the variability of daily rates during the period. The empirical evidence shows a strong positive correlation between the two parameters: as the mean casualty rate increases, the variability of daily rates about that mean (measured in terms of the standard deviation of the daily rates about the mean) also increases.

The following sections show the contrasting results of this portrayal of the empirical evidence and the model results for single divisions and single corps and armies.

Single Divisions

Figure 4-9 shows that, for single-division pulses, the simulation and empirical observations significantly overlap. About 30 percent of the simulation observations fall in the area defined by empirical experience. That overlapping suggests that, for these division pulses anyway, the simulation reflects a mean-variability relationship

that is reasonably consistent with that seen empirically. It further suggests that the simulation is inherently capable of representing – at the division level, at least – an apparently realistic mean-variability relationship.

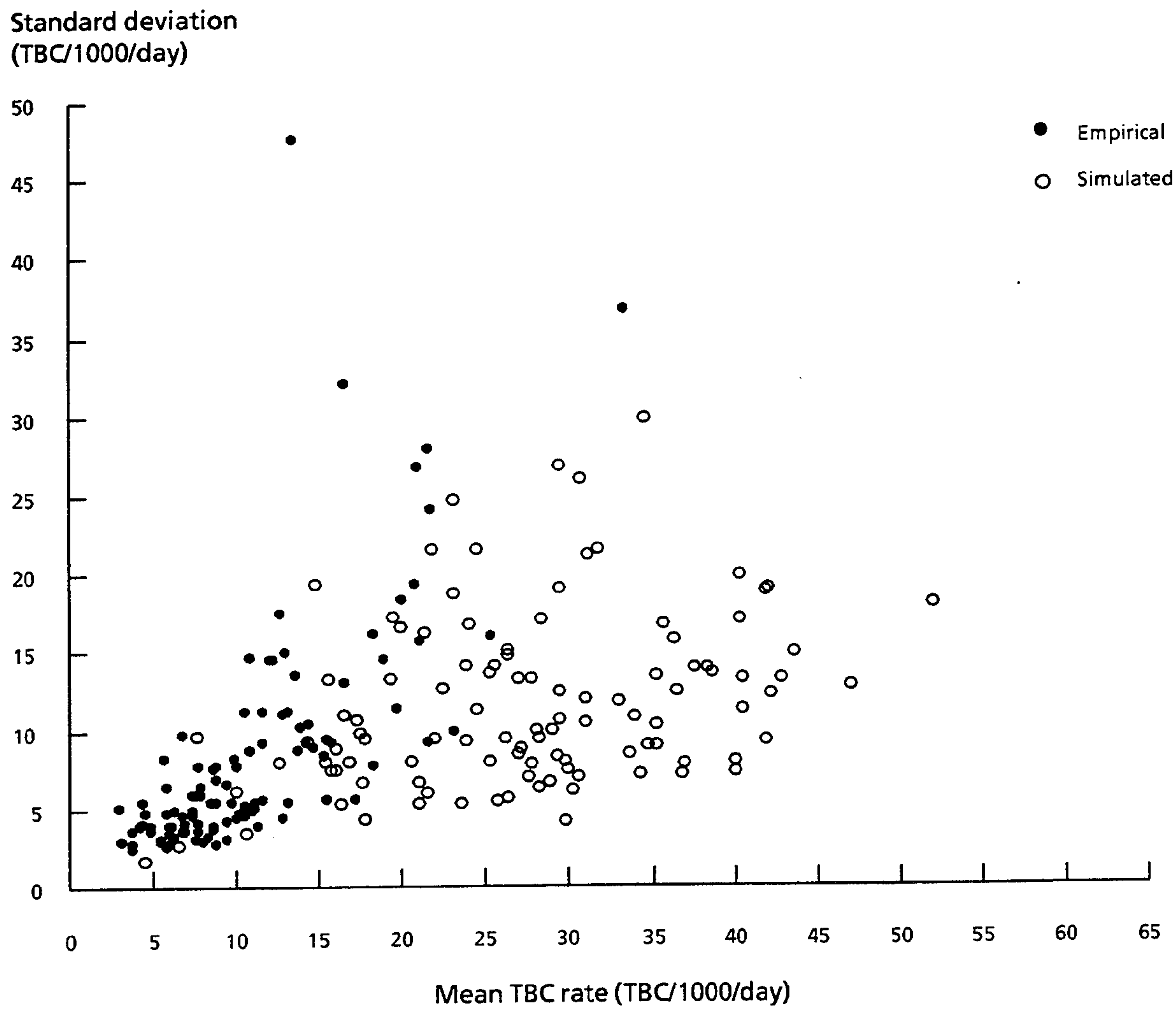


FIG. 4-9. MEAN AND STANDARD DEVIATION FOR 106 10-DAY DIVISION PULSES (Empirical and simulated)

However, the simulated casualty rates for most single divisions – including nearly all the U.S. divisions (see Figure 4-10) – fall outside the area defined by the empirical data. In particular, these simulation results fall nearly horizontally across the x-axis, which suggests that virtually no correlation exists between the mean rates and the daily variability of rates for these divisions.

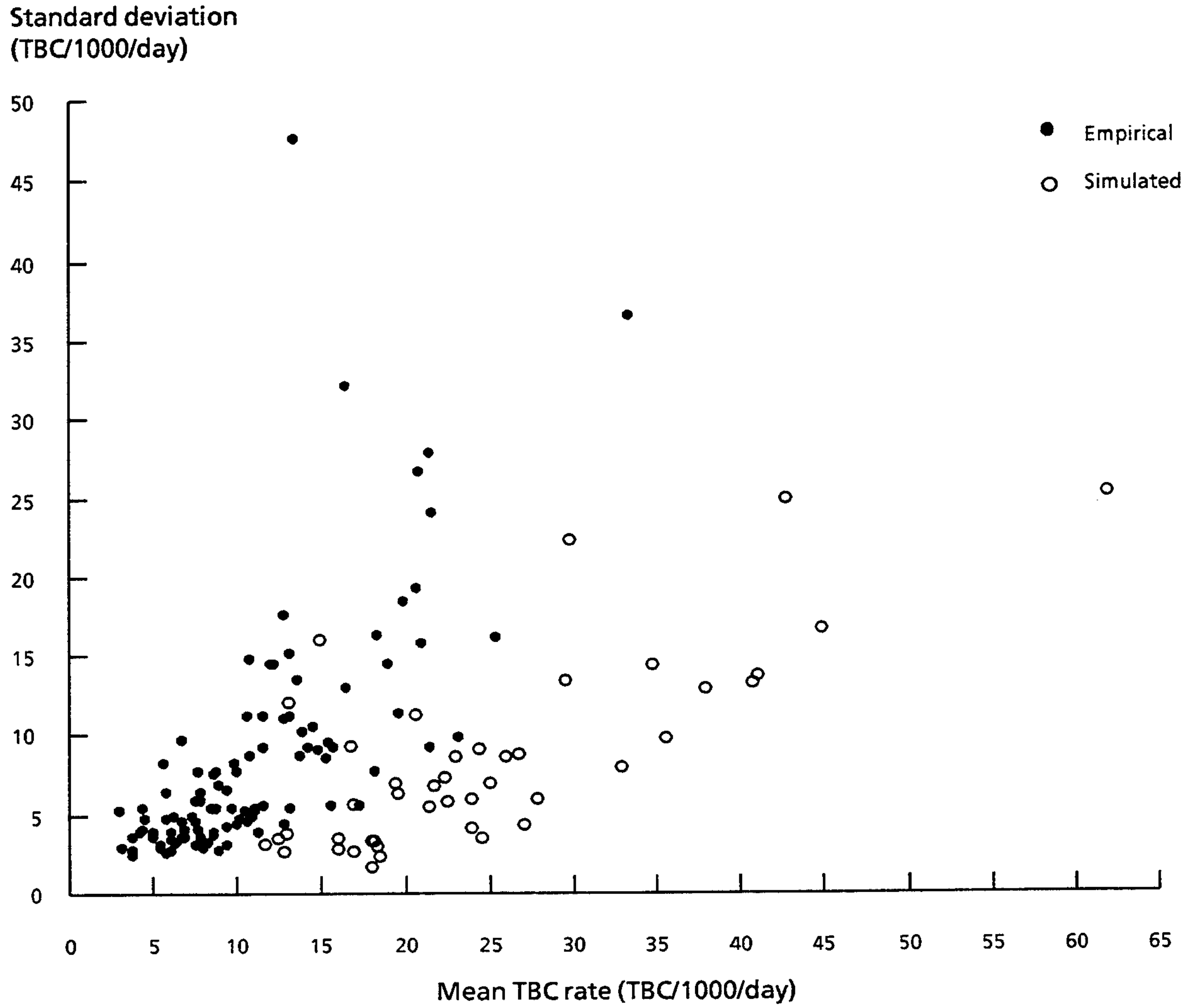


FIG. 4-10. MEAN AND STANDARD DEVIATION FOR 10-DAY DIVISION PULSES (106 empirical, 44 simulated U.S.)

In fact, this lack of correlation seems to describe the evident character of the simulation's division time series casualty rate curves that initially gave rise to our concern; most show little if any evidence of the curve characteristics of actual combat where pulses of high rates are separated by intervals of significantly lower rates, with high variability throughout.

The mean-variability relationship is a threshold measure of whether the rate curves are realistic. The fact that some 30 percent of the model division observations

chosen[4] fall inside the "realistic" area raises a second, related question of whether the *character* (or *shape*) of the divisions' rate curves is itself indicative of rate pulses and intervals.[5] That is, we must move beyond the threshold test of the mean-variability relationship.

Interest in curve shape is necessary to complete the purpose of the mean-variability analysis, which measures the simulation's representation of casualty rate pulsing and variability. It may well be that the variability measured in the mean-variability test – as it is in 30 percent of the division-level cases observed – is merely a more exaggerated version of the same uniform, nonpulsing curves seen across the rest of the sample. Thus, we take the further step.

Simulated rate curves with a reasonably realistic pulsing character will show a strong relationship between the rates on succeeding days, at least in the following sense: a high rate on a given day, x, will tend to be followed by a distinctly lower *average* rate over the period of days following day, x. The magnitude of the succeeding average will depend largely on (1) the magnitude of the rate at Day x, (2) the length of the period over which the average is measured, and (3) the force size (with echelon as a generally useful surrogate). The average will also depend to some degree on the fact that rates in the lower rate classes (e.g., in the range of 0-to-10/1000/day) are in any case far less variable than rates in higher classes. The higher the rate on Day x and the longer the succeeding period over which the average is measured and the larger the force, the more the succeeding average rate will fall compared to the rate at Day x – except that this falloff should slow as casualty rate averages reach into the lower rate classes.

Results of this comparison between actual combat rate patterns and the simulation's representation of combat rate patterns are shown, for divisions, in Figure 4-11.[6] The figures chart the relationship between a division rate on a day (x)

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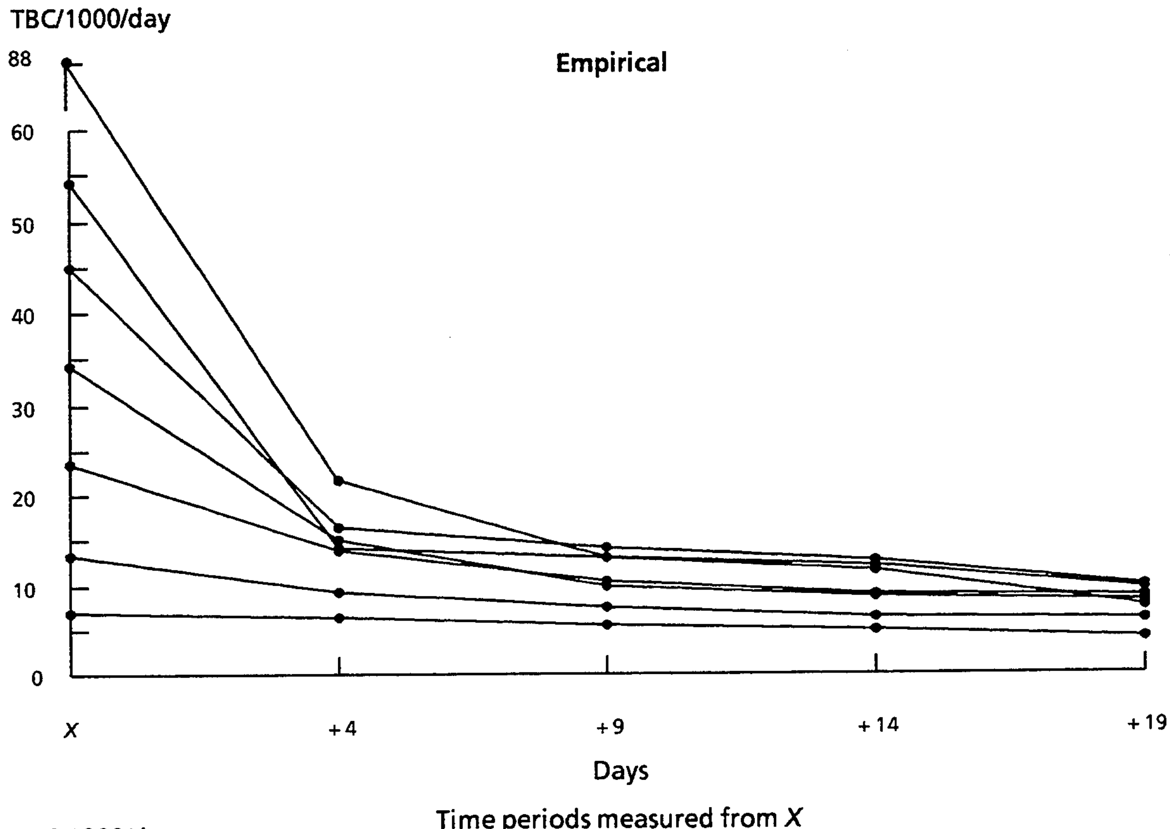
[4]When selecting 10-day increments for divisions (as well as corps and armies), we took care to include as often as possible cases in which the rate shifted suddenly from one magnitude to another. This selection biases the sample toward a more positively correlated mean-variability relationship since the sample includes those cases in which the curve suddenly shifts even though on either side of the shift the rate variability may tend to be fairly uniform and unrelated to the magnitudes of rates.

[5]Refer to discussion in the first report, Chapter 7 (especially pp. 7-4 and 7-5).

[6]Our analysis compared the simulation and empirical data for every Day x day rate, expressed as a member of a class of rates, for each division, corps, and army. We looked at the distribution of rate averages, for every such "x" rate, at $x + 4$ days, $x + 9$ days, $x + 14$ days, and $x + 19$ days.



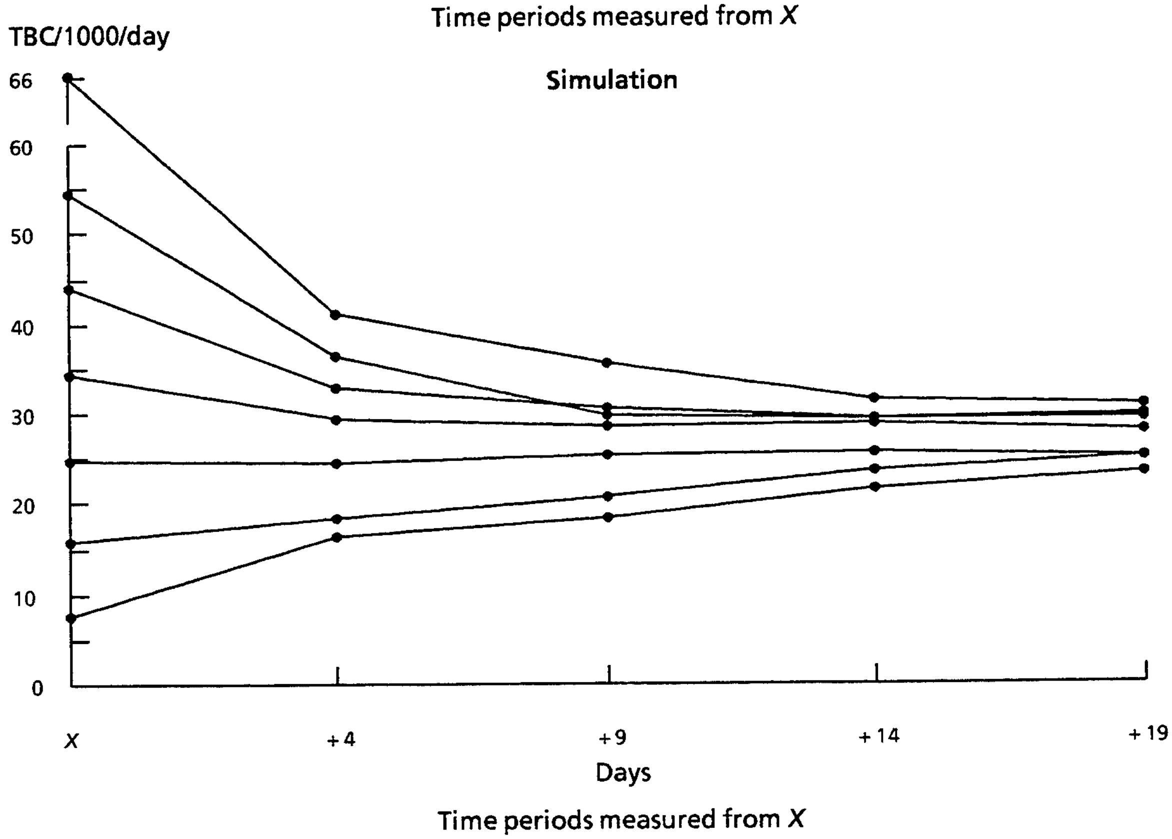


FIG. 4-11. DIVISION MEDIAN TBC RATES FOR DAY *X* AND FOR EACH SUCCEEDING TIME PERIOD

and the average rates (excluding Day x) measured over four succeeding periods of time. The periods are $X+4$ days (meaning the average for the 4 days following Day x not including Day x), $X+9$, $X+14$, and $X+19$ days. In each case – for Day x and for each of the succeeding period averages – the figure shows the median rate.

While the two figures may appear at first to depict similar results, closer examination shows they are in fact radically different. Most fundamentally, the empirical data show in all cases[7] that average rates for succeeding periods tend to fall below their Day x rates. The higher the rate at Day x and longer the time lag over which the succeeding average is measured, the further the rate drop tends to be. Conversely, the simulation's data show that regardless of the rate at Day x and the length of the succeeding averaging period, the succeeding days' average rates will tend to move toward a uniform long-term (10- to 20-day) average rate. If the Day x rate is above that longer term area of uniform averages (of between roughly 20-to-30/1000/day), the succeeding averages will fall toward the uniform range of rates. If the Day x rate is below that average, the succeeding averages will *rise* to meet the uniform range. If the rate at Day x is already within the uniform range, the succeeding averages will simply remain equivalent to the Day x rate.

Finally, we turn to a second aspect of the shape of rate curves. While certain patterns are known through median experiences, combat is obviously not adequately described only by median experiences. Rate pulsing means that for any Day x rate, the average rate(s) during *some* succeeding time period will be quite high relative to the rate on Day x, even if the rate on Day x is high. Obscured in Figure 4-11, which depicts median experiences, is the subset of the highest succeeding average rates for each class of Day x rates – the subset, that is, which more particularly reflects succeeding rate pulses.

We take but one example to show the contrast again between the simulation and the actual combat data with regard to this second aspect of the shape of rate curves. For the simulation and the empirical sets of data, we selected a low and a high rate for "x" and then looked at the *upper half of the range* of the average rates over the succeeding 19 days. The low rate selected in each case (for the simulation

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[7]We exclude the sets of rates and succeeding averages for Day x rates below 5/1000/day. As expected, these low rates are followed by average rates that are higher – the effect of rate pulses after cases of exceedingly low rates. Both the empirical data and the simulation's data exhibit this tendency although the simulation's succeeding averages strongly seek those same high long-term rates shown in the graphs for averages following the higher Day x rates.

and the empirical data) was the median rate in the class of Day x rates from 5-to-10/1000/day. The high rate for each was the median rate in the class of Day x rates over 60/1000/day.

Given the nature of rate pulses and variability, we would expect that for any set of Day x rates defined in a rate class, the upper half of the range of some succeeding time period's group of average rate experiences would be relatively broad. We expect that because actual operations data show combat rates occurring in pulses and being distinctly skewed in the direction of high rates.[8] The longest of our four multiday periods of succeeding rate averages (19 days) is the most likely one to include any rate pulse(s) subsequent to the Day x experience.

A related expectation is that as the set of Day x rate experiences examined includes increasingly higher rates, the range shown in the upper half of the distribution of associated succeeding (lag) average rates should itself extend. That is, the range between the median and maximum rates in that lag distribution should extend as the median Day x experience is located higher on the overall scale of rates. This is due, once again, to the fact that combat occurs in pulses. If one encounters a high 1-day pulse, the likelihood increases that other such pulses will also be encountered in relatively close, successive time periods.

Figure 4-12 displays the results. The empirical data behave as expected. The upper-half ranges are relatively broad, even when the associated "x" rates are low (a lag upper-half range of 4-to-19 when x is at 5-to-10/1000/day). And the high x rates have an associated lag upper-half range that is truly broad (8-to-77 for an x at >60/1000/day). This upper-half range covering 70 rate points denotes other pulses in relatively close time proximity to the pulses that define the high x rate itself.

Not surprisingly, the simulation exhibits uniformity of rate behavior. The two upper-half ranges both fall into roughly the same area of values (23-to-38 and 31-to-47). Both are of about the same length – regardless of the fact that each is tied to a Day x rate that falls at radically different parts (one low, one high) of the rate spectrum.

In summary of single division analysis we can state the following: A uniformity of rate experience dominates in the simulation even though there are cases of

[8]See the earlier report, especially Chapter 10 and the Statistical Appendix.

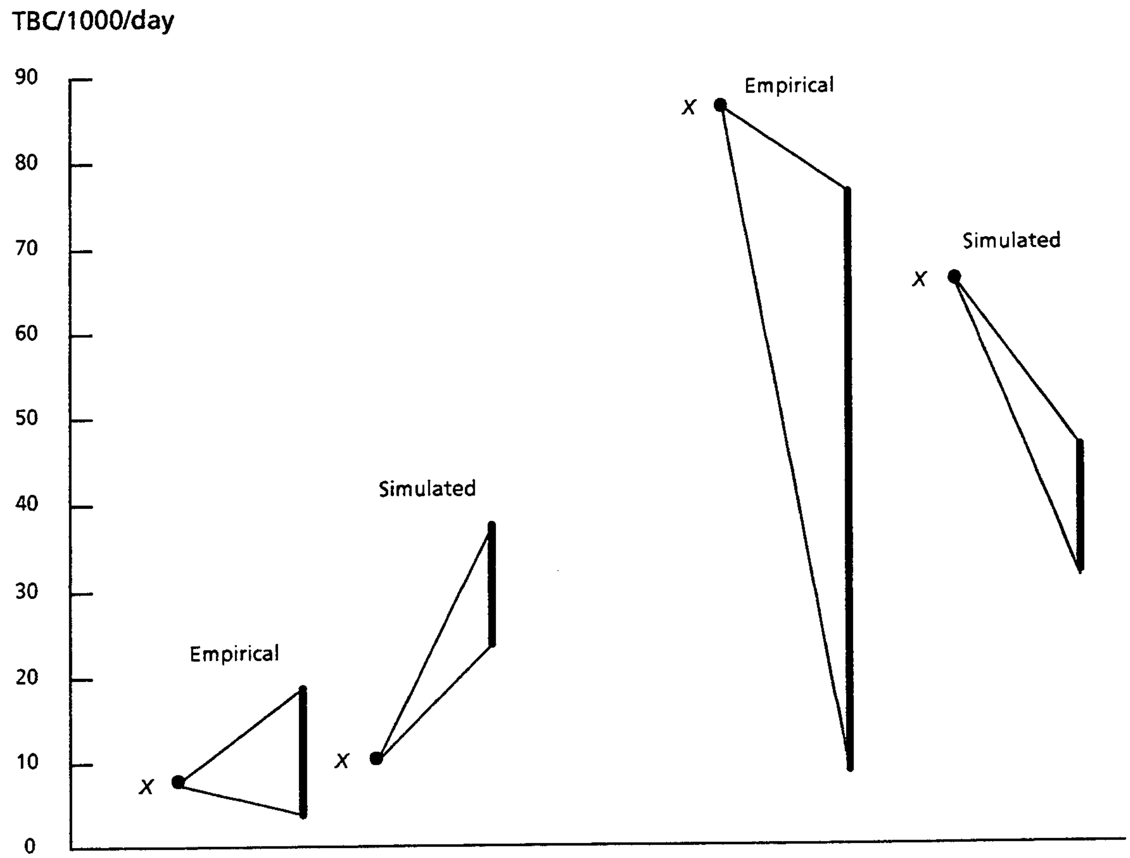


FIG. 4-12. RELATIONSHIP OF DAY *X* RATE TO UPPER HALF OF DISTRIBUTION OF RATES FOR *X* + 19 DAY TIME PERIOD

(Empirical and simulated data)

divisions where the mean-variability relationship appears credible. Contrary to real combat, and even at the low tactical level of single divisions, rate pulsing and variability – as seen in such measures as the mean-variability relationship and the shapes of rate curves – are not the driving features of the simulation.

Single Corps and Single Armies

As the perspective of analysis rises to the levels of corps and armies – that is, as the perspective rises from the clearly tactical level of individual divisions to the higher aggregates of divisions – the model's representation of a credible mean-variability relationship simply collapses.

Figures 4-13 and 4-14 clearly show that for the set of actual corps and army experiences, variability once again strongly rises with rising mean rates. The figures

also show that in the simulation's representation of corps and army combat, no relationship whatever exists between the magnitude of a 10-day mean rate and the amount of daily variability seen during the period. At every mean rate, low to high, the variability is virtually identical for the simulated corps and army pulse periods.

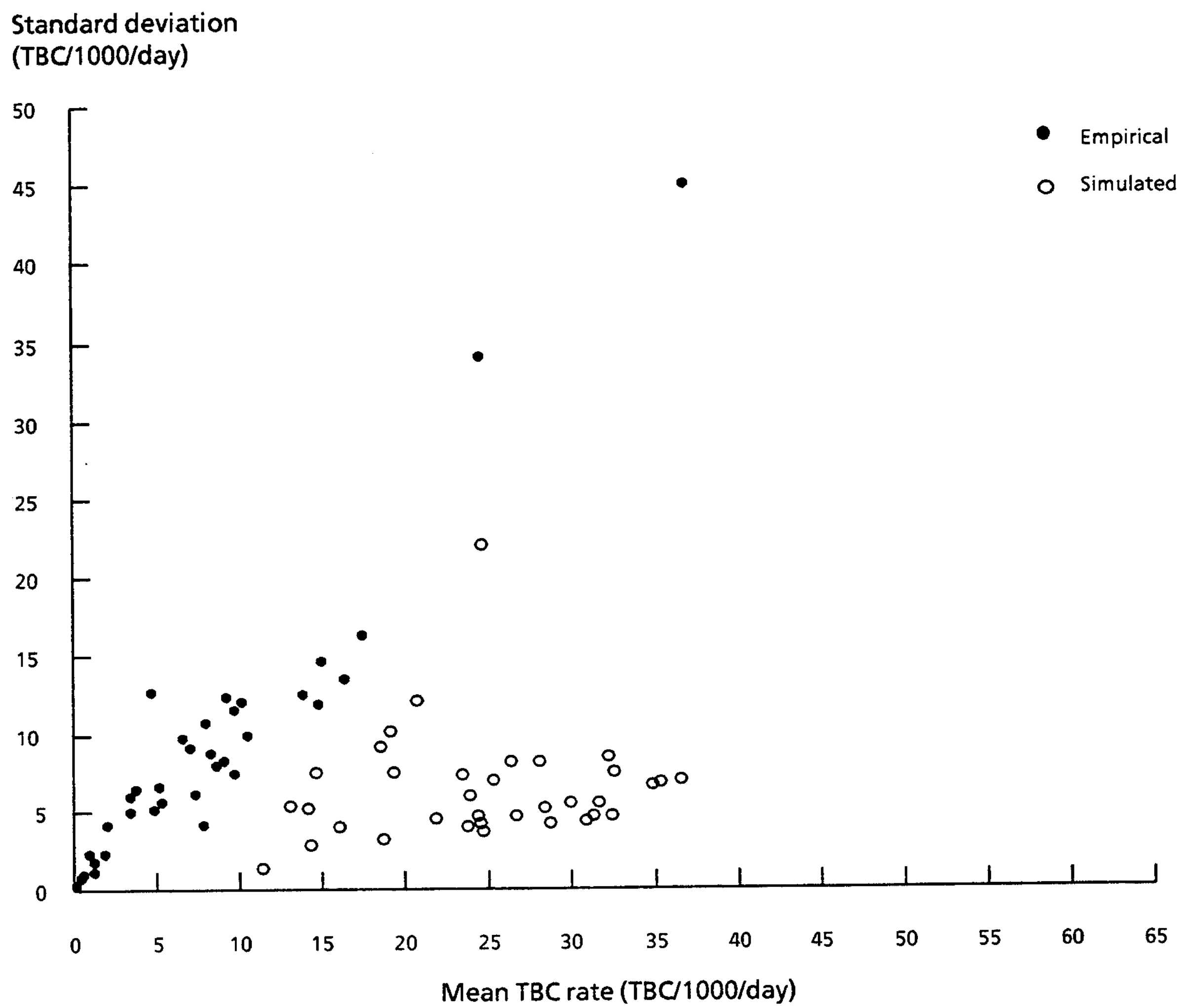


FIG. 4-13. MEAN AND STANDARD DEVIATION FOR 35 10-DAY CORPS PULSES
(Empirical and simulated)

Figures 4-15 and 4-16 compare simulation and empirical data on rate curve shapes for divisions grouped in corps and army formations.

The same general observations on differences between the simulation and empirical data curve shapes apply to corps and army rate curves as to division rate

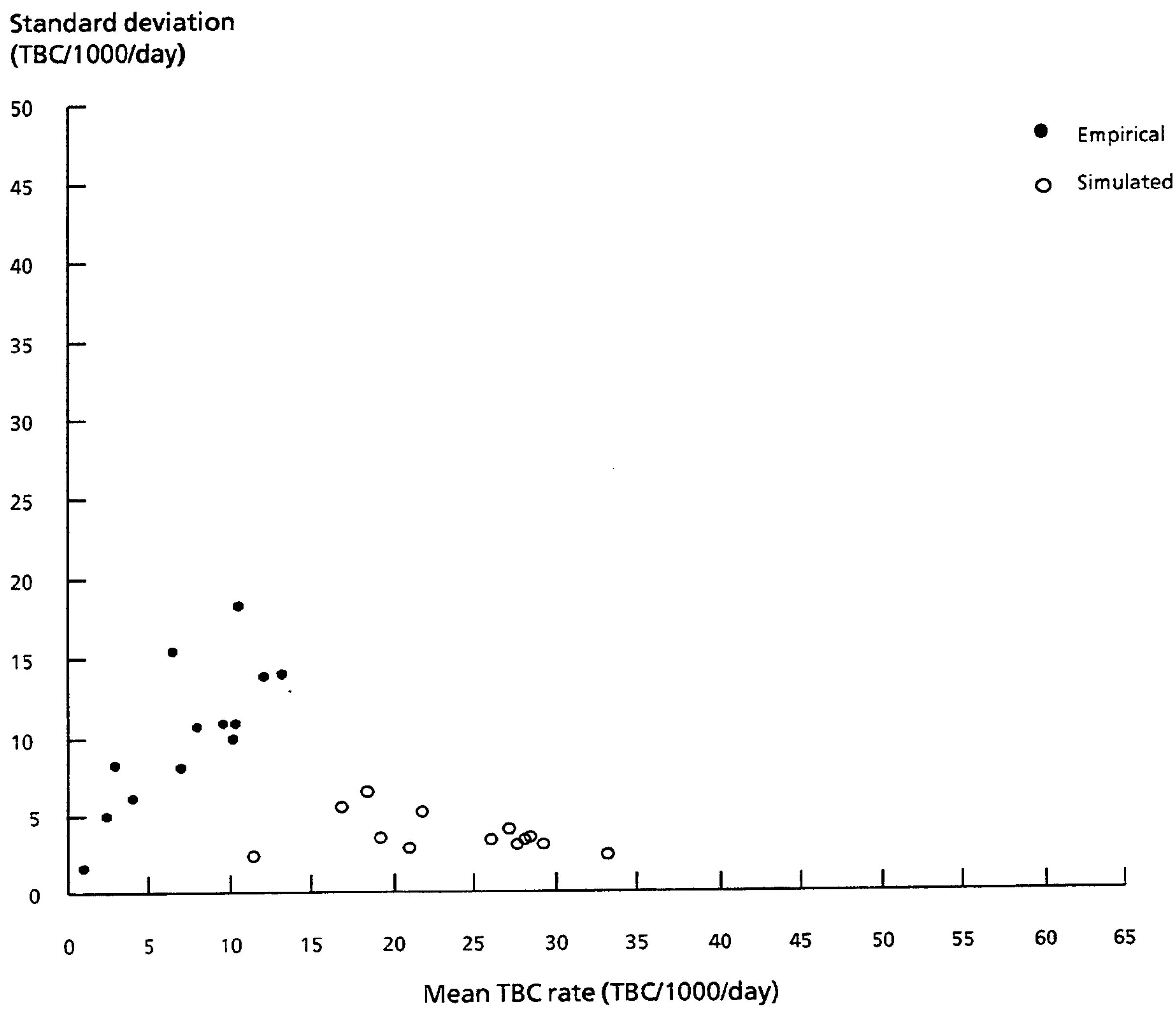
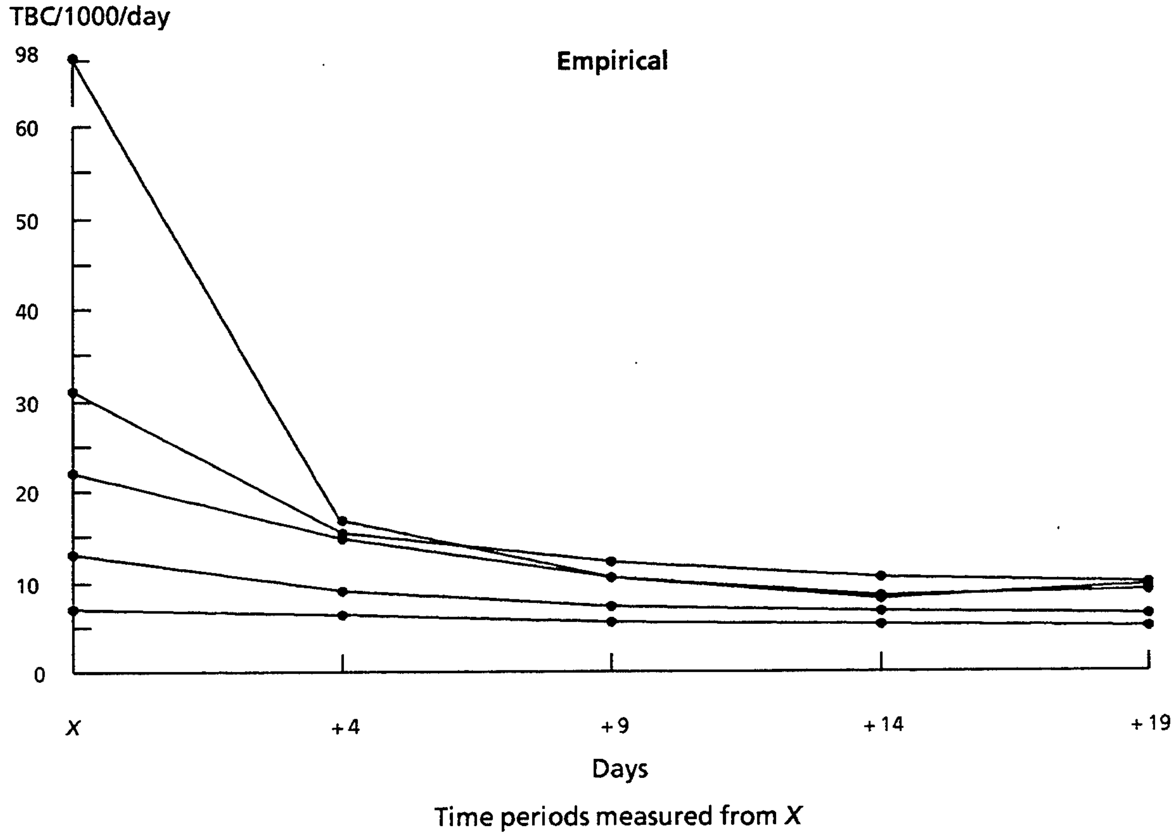


FIG. 4-14. MEAN AND STANDARD DEVIATION FOR 13 10-DAY ARMY PULSES
(Empirical and simulated)

curves. Whereas the empirical data show a distinct decline over the lag periods, the simulation data again tend to seek a mid-level rate – a rate that causes the lag data for the lower Day x rates to rise as much as those for the higher Day x rates to fall.

An additional observation on corps and army rate curve shapes, however, is critical. It concerns the impact of force size on the rate values in the four groups of averages following Day x values in any given rate class.

For the empirical data, the rate averages on successive periods of days following a Day x rate in a given class will differ between army and corps data. Army-level sets



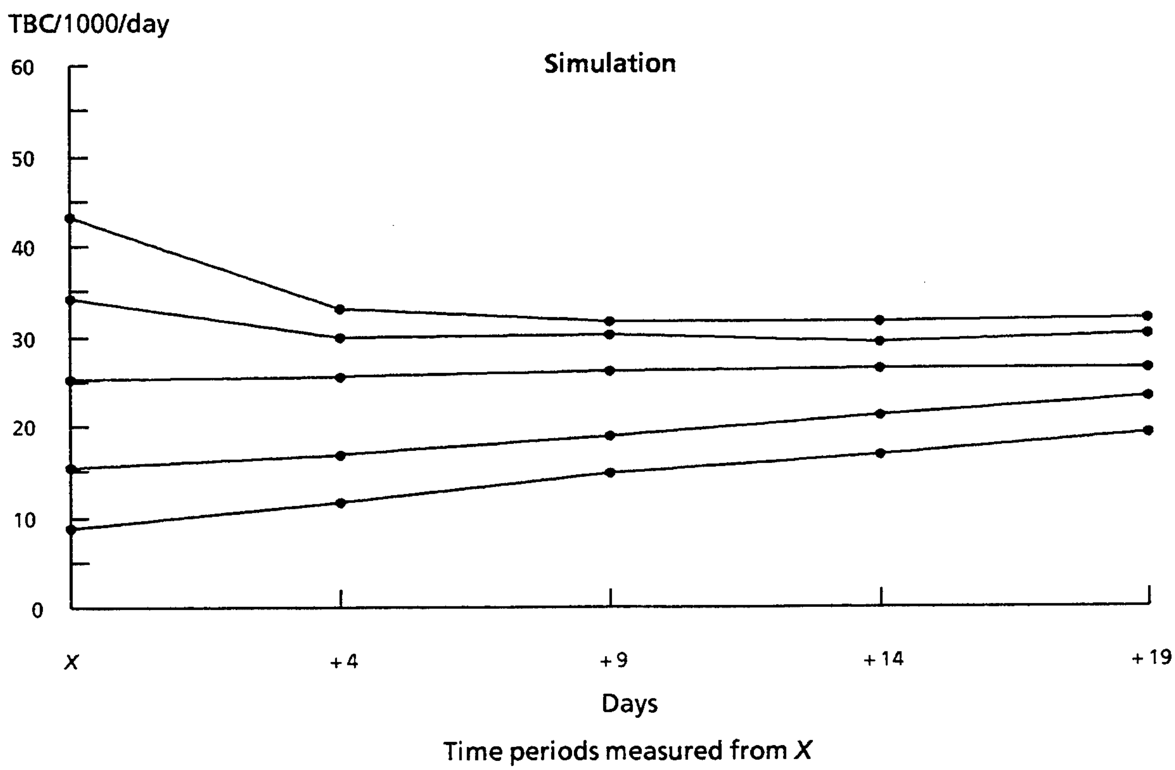
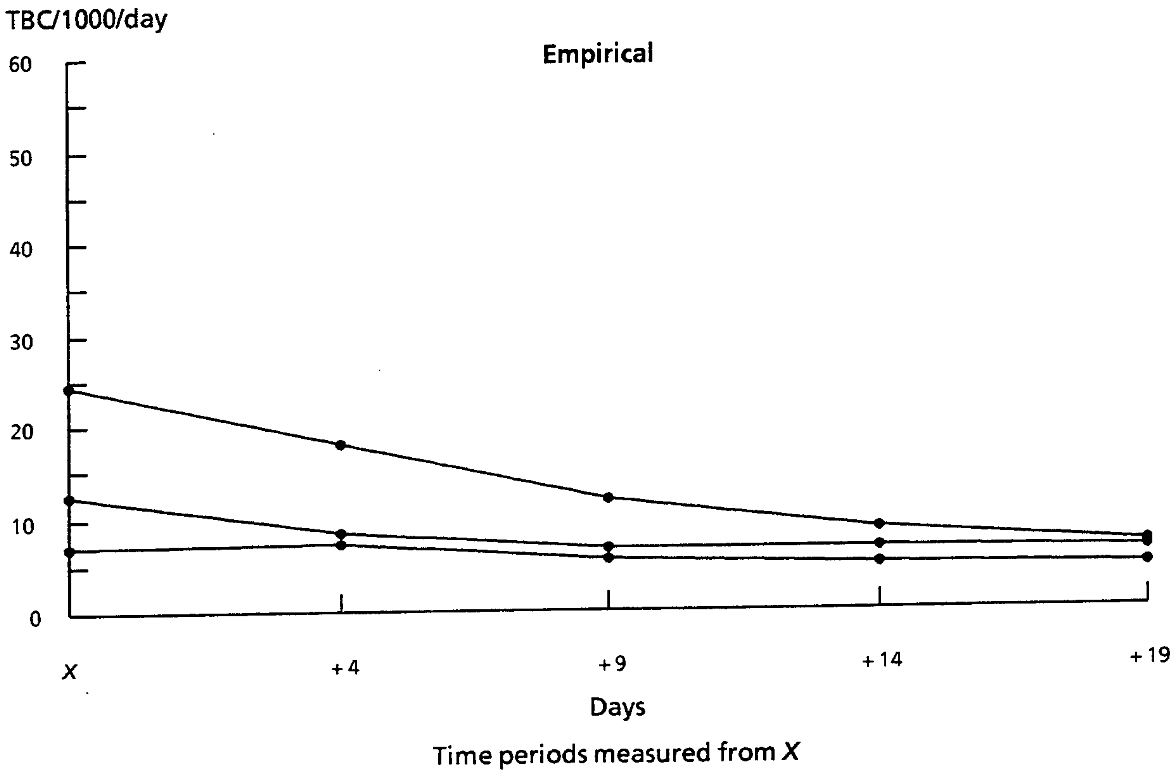


FIG. 4-15. CORPS MEDIAN TBC RATES FOR DAY *X* AND FOR EACH SUCCEEDING TIME PERIOD



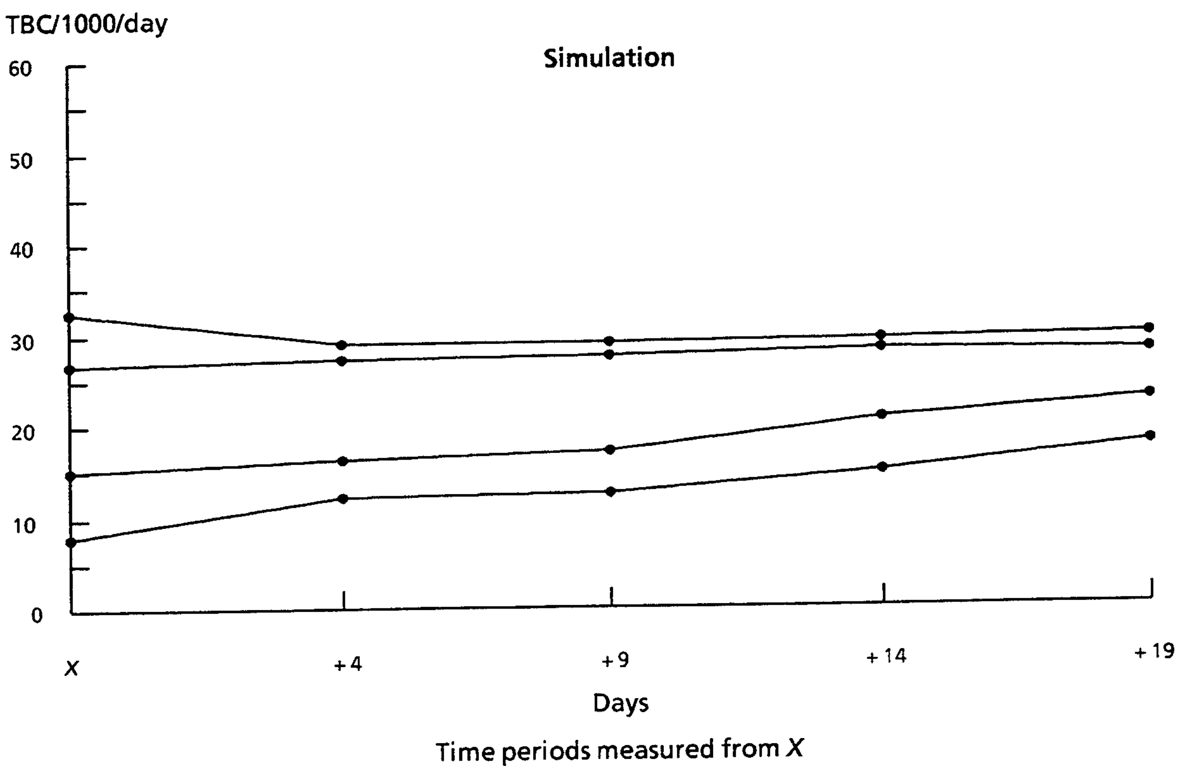


FIG. 4-16. ARMY MEDIAN TBC RATES FOR DAY *X* AND FOR EACH SUCCEEDING TIME PERIOD

of succeeding average rate values are generally lower than the sets of succeeding average values for the corps Day x values in a given rate class. Army-level rates are expected to be lower since, of course, army daily rates will in general be lower than corps daily rates.

Nevertheless, the simulation produces succeeding rate averages that are nearly identical at the corps and army echelons for the same sets of Day x values. In other words, in the simulation there is *essentially no distinction* in longer-term average casualty rates between corps- and army-size formations of divisions. Further, when these values for the simulation's corps and army formations are compared with the values for its individual divisions, again precious little difference is seen.

In summary of single corps and army analysis, we are not surprised that the simulation's representation of casualty-producing phenomena appears so unrealistic at levels that approach or attain the operational level of war. The simulation is by design closely tied to the tactical rather than to the operational level of war. The stochastic feeder model (termed "COSAGE") that supplies the theater-level deterministic model (CEM) with likely engagement outcomes (based on probabilities of engagement, fire, hit, kill, etc., for given force types and ratios) attempts to represent strictly tactical engagements of opposing weapon systems. However well the lower level model may represent these tactical interactions – a subject we do not address – the question is how such interactions are translated into a set of interactions across the broader level of forces which credibly represents the manner or character of such interactions when seen from that higher level.

This mean-variability analysis suggests that whereas, for single divisions, at least a threshold test of the credibility of rate curves is passed for a minority of individual division 10-day periods – a credibility, however, soon dissolved with further analysis of the character of divisional rate curves – that credibility never even surfaces for the model's representation of rates at the higher echelon. The simulation's corps and army rate curves are shown to be wholly out of touch with the empirical evidence concerning rate variability in relation to rate magnitude.

Summary of the Simulation's Representation of Rate Patterns in Time

Initial analysis of the simulation's casualty rate patterns in the time dimension alone points to a superficial adequacy of rate representation for a minority of the

individual (mostly non-U.S.) divisions.[9] However, that representation ultimately proves inadequate even for these divisions and thus even at the strictly tactical level of single divisions.

More to the point, the analysis shows a complete breakdown of the simulation's ability to represent casualty-producing combat phenomena at the corps or operational level. As noted in the Introduction and in our remarks on Methodology, these phenomena do not have the character of intense tactical-level rate experiences merely spread across an operational time span and frontage. An intense operational-level campaign has its own distinctive character – a character that, in a sense, shapes the scope and number and relative proportions of the various kinds of tactical events that comprise it.

CASUALTY RATE PATTERNS SEEN LATERALLY ACROSS A FRONT

A second dimension where casualty rate patterns may be measured is along the front across which rates are spread laterally. This perspective looks at combinations of rates when the entire front is considered as a 1-day slice or the front is seen in 1-day slices sequentially over a longer period of time.

This section compares empirical and simulation data in terms of two measures of this lateral picture of rates: the count (or percentage) of divisions in the force that fall daily into different classes of rates, and the force's set of division daily rate experiences shown distributed from high to low.[10]

Daily Proportions of the Force by Rate Class

Figure 4-17[11] shows the daily proportions by rate class of the principal American force of divisions in Northwest Europe from mid-June 1944 to the end of

[9]That even some divisions exhibit a credible mean-variability relationship indicates that the simulation is at least capable of realistic rate behavior at the division level. This fact would seem to be a hopeful one in terms of attempts to work toward greater realism across the rest of the simulation. The great gap seems to be between representation of individual division results and realistic representation of combat activity across higher aggregates (corps and armies) of divisions.

[10]While reference is made in this section to the roles of different kinds of sectors – breakthrough sectors, etc. – we do not address such sectors directly until we consider scenarios.

[11]Figure 7-7 in the first LMI report.

April 1945.[12] The force grew from one to three armies on line over the period,[13] or from 11 to some 50 divisions.

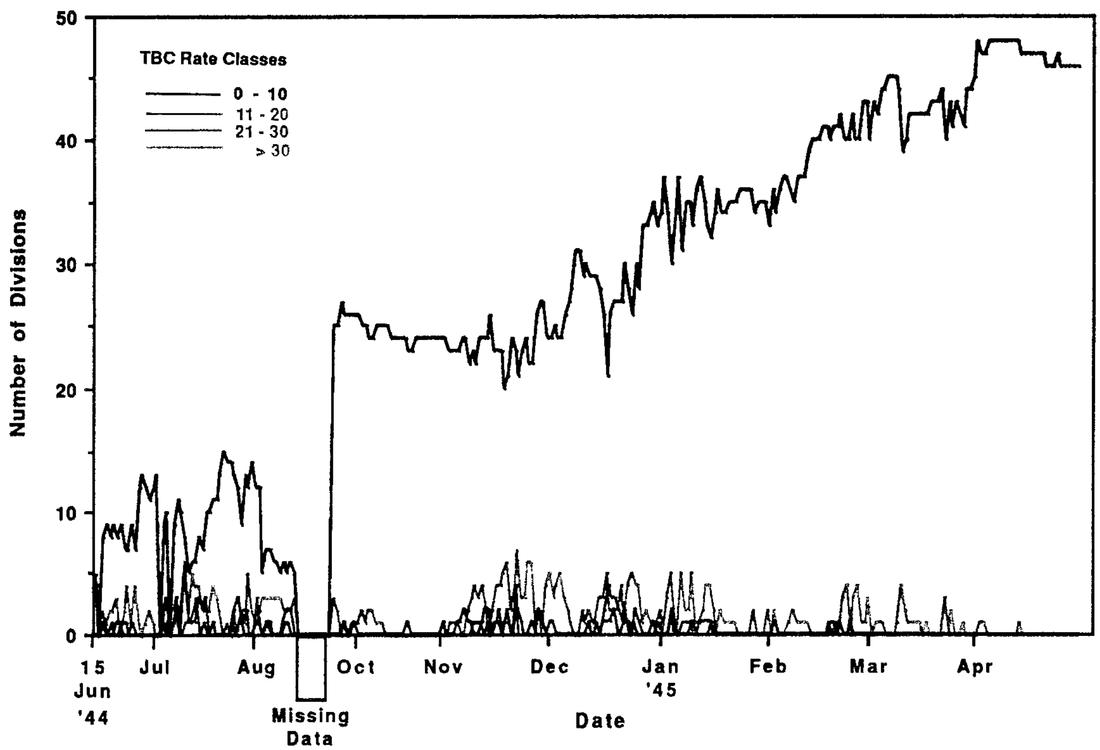


FIG. 4-17. EMPIRICAL THEATER FORCE DAILY CASUALTY EXPERIENCE
(Number of divisions in rate class)

One of the critical features shown in Figure 4-17 is that the proportion of the force experiencing high casualty rates on any given day – say, rates in the classes of 21-to-30/1000/day and >30/1000/day – *diminished* as the force size grew. This was the case even though the Ardennes defensive, which occurred when the force had grown to more than 30 divisions, was the largest-scale operation and involved the most intense casualty rates seen.

Figure 4-18 differently portrays this diminishing proportion of a growing operational-level force. The figure focuses within the longer time line on the two

[12]Our first report details the data gaps. The main gap extends from 11 August through 30 September 1944.

[13]As again noted in the previous report, the U.S. Fifteenth Army is excluded from the analysis.

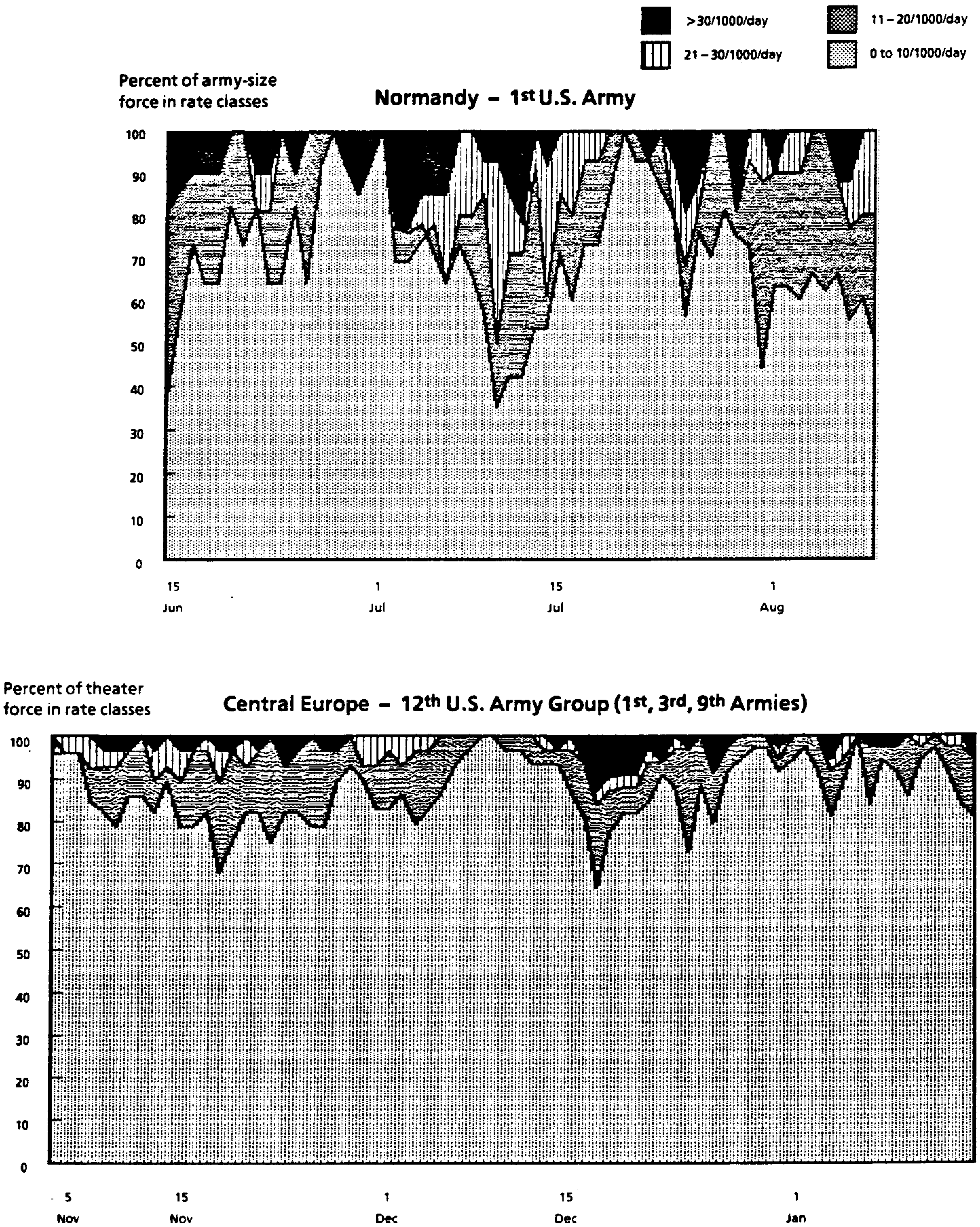


FIG. 4-18. PERCENT OF THEATER FORCE (DIVISIONS) BY RATE CLASS BY DAY

(Two focused time periods – 57 and 72 days)

roughly 60-day periods of greatest sustained combat intensity. The first is the Normandy period up to the early days of the Allied breakout (57 days, from 15 June to 10 August 1944). The second is the period (72 days, from 5 November 1944 to 15 January 1945) in Central Europe approaching and breaching the German border defenses, the last 31 days of which (16 December to 15 January) are the Ardennes defensive campaign.

The first period illustrates the proportions seen with a single army, the 1st U.S. Army, covering a relatively narrow operational frontage (up to roughly 50 miles, or 80 kilometers). At the time, this one army constituted the entire U.S. force in Northwest Europe. The second period represents a three-army force – which itself, however, was by that time only one of three army groups across the full Western Front as it moved into Central Europe. On 16 December, this 12th Army Group occupied about 145 miles (240 kilometers) of an overall 350 to 400 mile (580 to 660 kilometer) theater frontage.

Figure 4-19 looks within the full 12th Army Group during the second period (5 November to 15 January) at two single armies' rates. These are chosen to show both the single-army perspective (of those armies carrying most of the casualty burden during the specified times) and the difference in single-army rate proportions between the Central European and Normandy periods (see 1st Army, Figure 4-18).

The diminished proportion of high rates for the larger operational-level force does not, we think, suggest that the proportion necessarily diminishes steadily as long as any such force grows. Instead, it appears to reflect mostly the fact that as an operational front grows broader, it will experience its heaviest combat in sectors whose combined widths do not occupy nearly as much of the overall front as do the intense sectors of a narrower overall front. This fact merely reflects at the operational level the more general fact of ground combat at any echelon: its "hottest" spots are distinctly localized. At the operational level, as at the tactical, the offensive commander *focuses* effort to achieve the kind of combat power superiority judged necessary. As the operational-level frontage lengthens (for example, from one to three armies wide), that focus occupies less of the overall frontage.[14]

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[14]Classic Soviet offensives on the Eastern Front saw overall operational frontages that ranged from 120 to 270 miles (200 to 450 kilometers), with several breakthrough sectors per operation focused on widths of frontage that totaled from some 15 to 35 miles (25 to 60 kilometers).

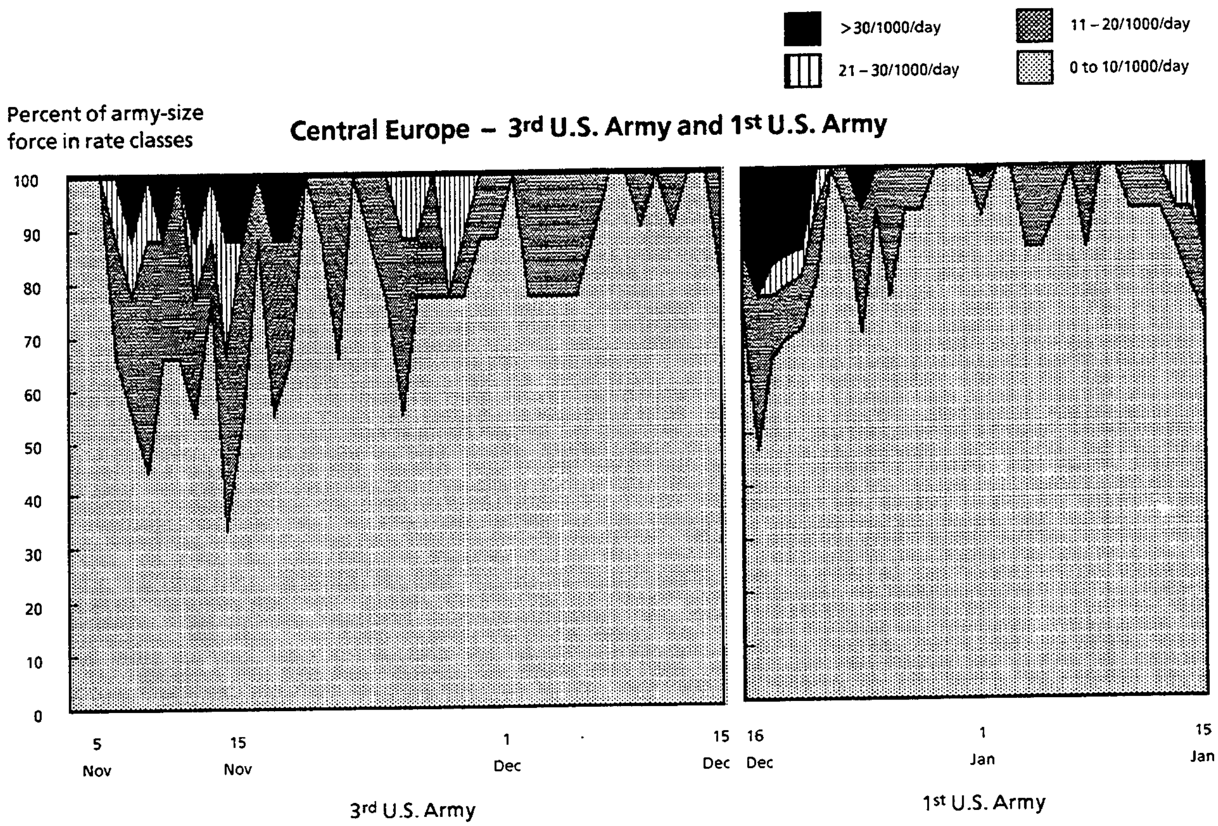

FIG. 4-19. PERCENT OF ARMY-SIZE FORCE (DIVISIONS) BY RATE CLASS BY DAY
(Focus on single armies within theater force)

Having shown the proportions of force per rate class exhibited by the empirical data, we now display (in Figures 4-20 and 4-21) the comparable proportions of force per rate class for the simulation's representation of divisions across the entire NATO defensive front.

The simulation represents a far larger operational front than the one occupied by the 12th Army Group. As noted, the 12th Army Group was only one of three army groups on line – all of which, together, occupied about the same overall frontage as that represented in the simulation. Thus, the proportions of the simulated force falling into the higher rate classes certainly ought to be no higher than those in the empirical data set, and probably should be noticeably lower.

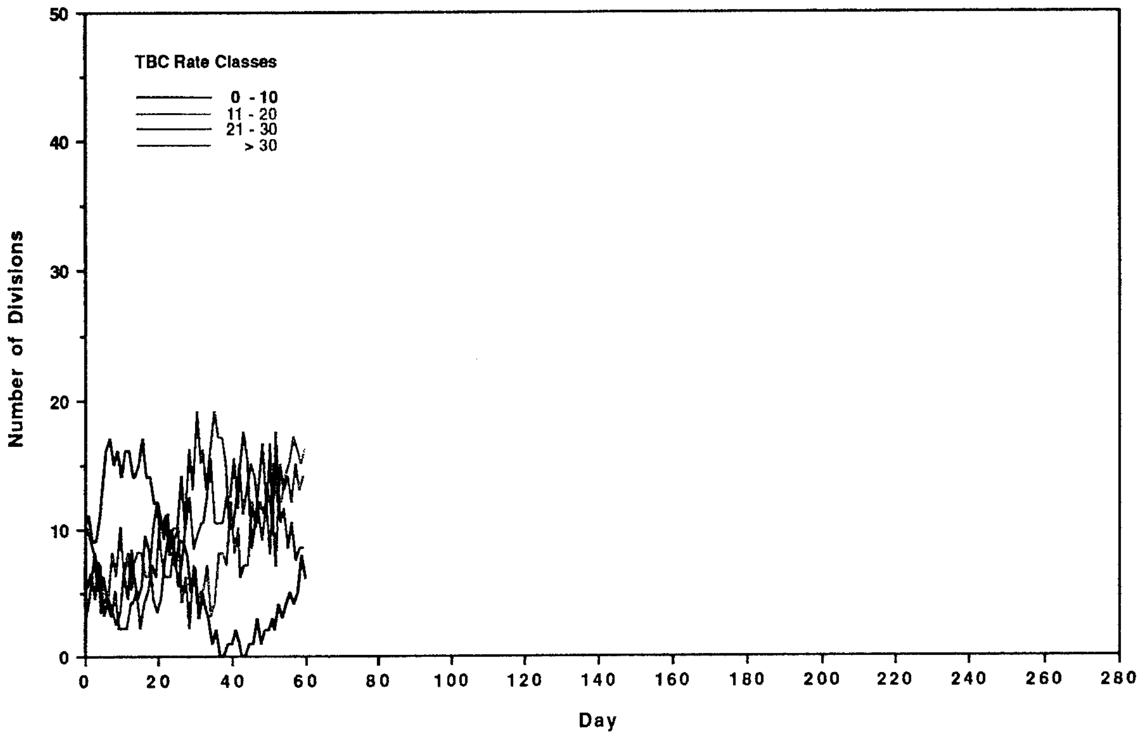

FIG. 4-20. SIMULATED THEATER FORCE DAILY CASUALTY EXPERIENCE

(Number of divisions in rate classes)

Instead, as shown in Figure 4-21, the reverse is true. With occasional exceptions, the proportion of the simulated theater force at or above 30/1000/day begins at about 30 percent of the overall NATO force, drops for something over 2 weeks to about 15 to 20 percent, and then returns to 30 to 50 percent for nearly 6 weeks. The defender force grows during this 60 days from over 20 to over 40 divisions.

Daily Distributions of Force Rates

A second way to view patterns of rates as they occur across an operational front is to measure their distribution by day, taking the echelon (corps or army) as a rough measure of the size of the frontage represented.

We again present empirical data for the U.S. force in Northwest Europe in 1944-45. Figure 4-22 displays that force during two roughly 60-day periods of greatest combat intensity as the force grew from one to three armies. Figure 4-23

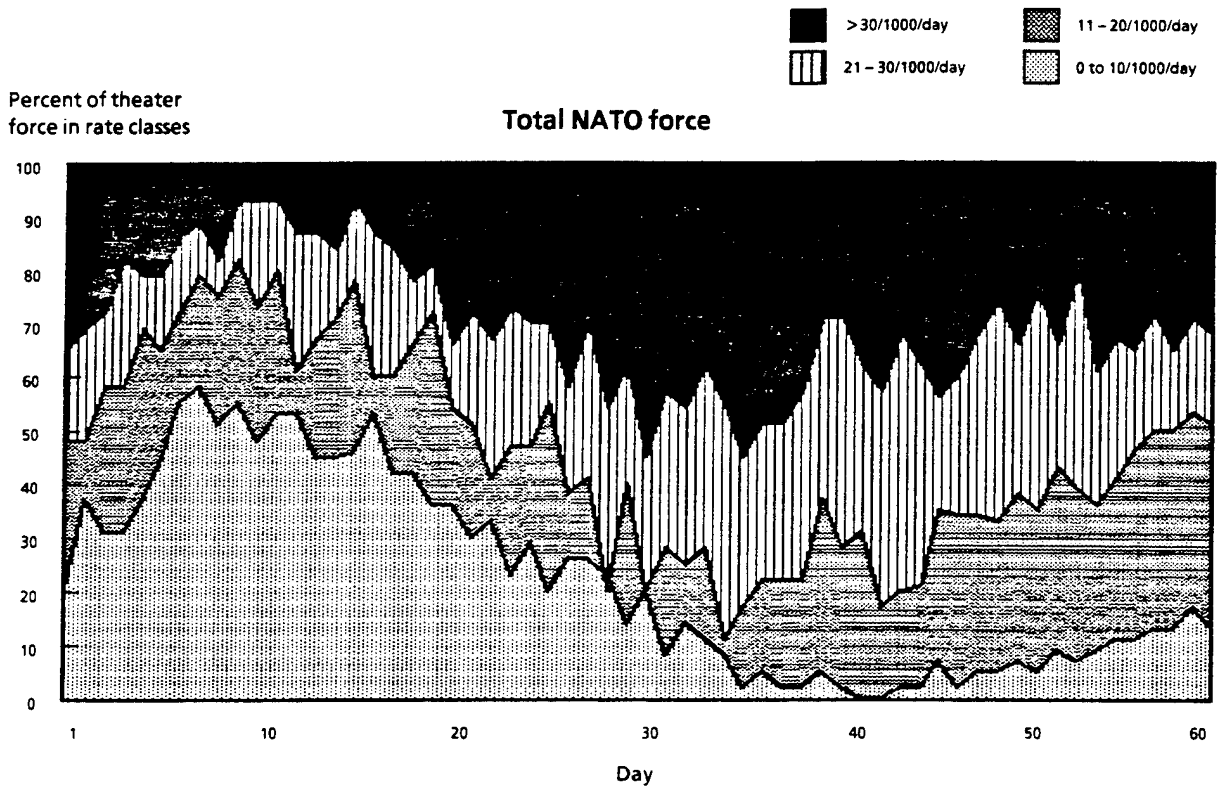

FIG. 4-21. PERCENT OF THEATER FORCE (DIVISIONS) BY RATE CLASS BY DAY SIMULATION RESULTS

then provides the same information for the simulated theater force for 60 days spread over a far larger operating area.

- Even when we represent a larger force and operating area, the simulated force's *median* rate is often higher than the *maximum* rates actually experienced in combat. On the other hand, the simulated force's maximum rates do not match the maximum rates seen in actual combat.

Summary of the Lateral Analysis

This lateral analysis leads to the same kinds of results as seen in the time analysis: the simulation is little if any better at reflecting rates seen across the lateral dimension of operations than it is of reflecting the temporal aspects of rates. In the simulation, high rates are not nearly as high as they should be in certain sectors; in a similar sense, the simulation's low rates are not as low as should be expected. The hallmark here, as with rates over time, appears to be consistency of

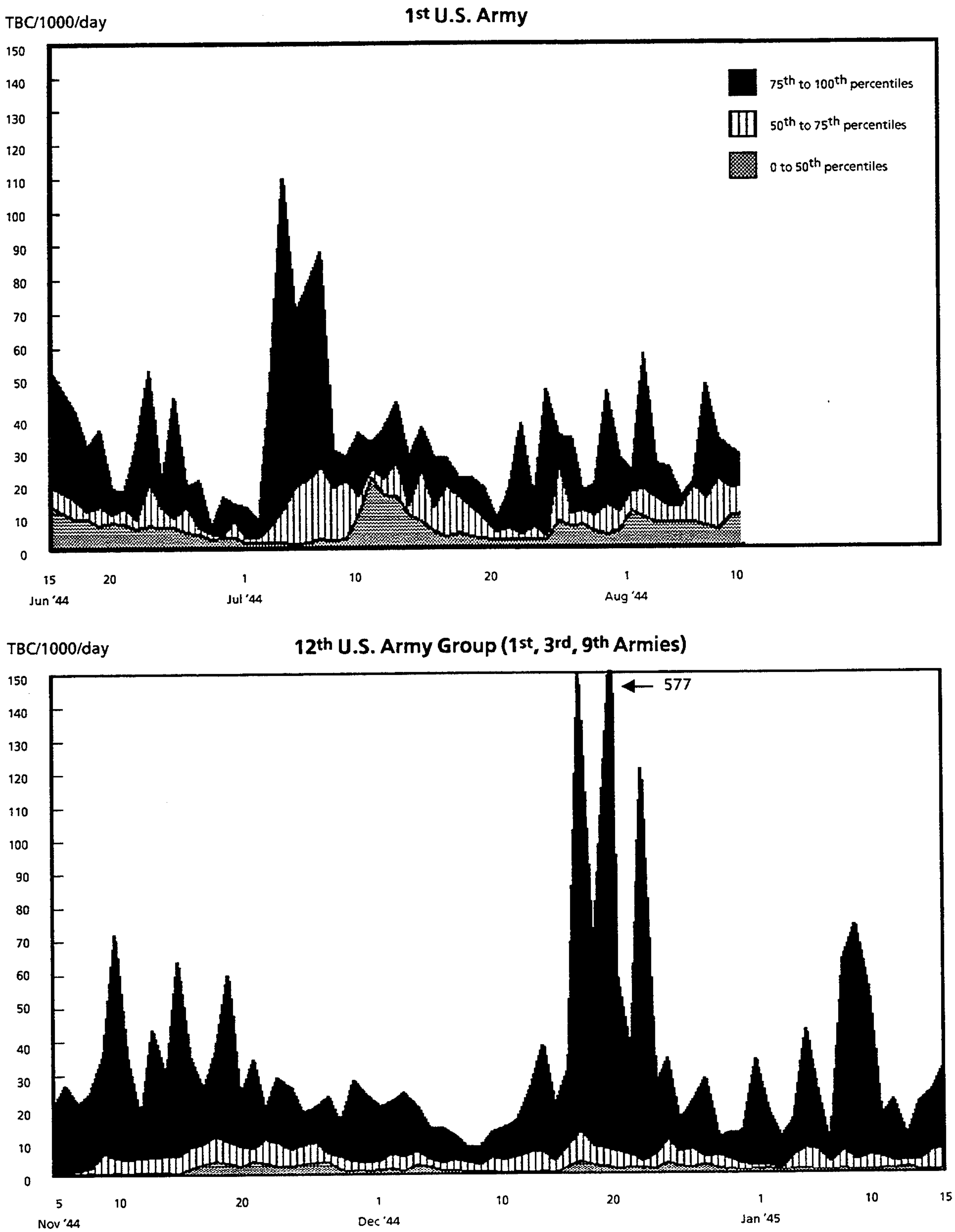

FIG. 4-22. EMPIRICAL THEATER FORCE DAILY CASUALTY EXPERIENCE

(Distribution of force's division TBC rates by day)

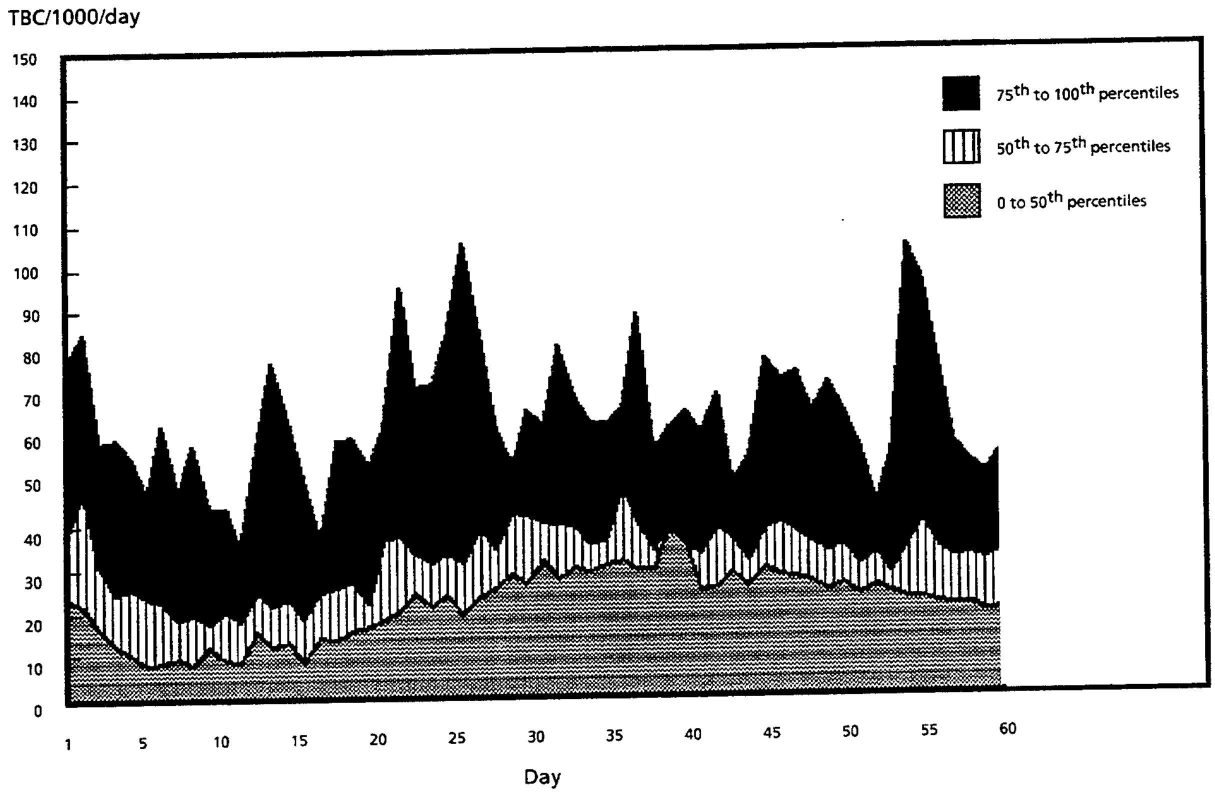

FIG. 4-23. SIMULATED THEATER FORCE DAILY CASUALTY EXPERIENCE
(Distribution of force's division TBC rates by day)

rates rather than, as the empirical evidence would suggest, rate pulsing and variability according to sector type and breadth of front.

FORCE POSTURE AND CASUALTY RATES IN THE SIMULATION

Certain analyses have convincingly suggested that ground forces casualty rates depend, among many other considerations, largely on the relative posture and success of the two opponents. We thought it useful, therefore, to examine any evident association between unit postures and casualty rates. Our thought was that perhaps the fact that, in the simulation, NATO units are generally on the defensive and being pushed back would help account for the high rates.

The Omnibus 89 database includes a field stating the "mission" of the brigade-size unit on the NATO side. These missions are either delay, defend, attack, reserve, or "cavalry." (The latter is a mission for a covering force – a brigade-size aggregation of personnel and systems not limited to true cover-type units but in fact

including any nonmaneuver brigade combat personnel and systems counted for purposes of the simulation as part of the division.) We took these data for the maneuver brigades that comprise divisions (after first identifying both delay and defend as defensive missions) and identified division missions as well by assuming that any two such brigade missions would adequately identify the overall division's mission.[15]

Tables 4-1 and 4-2 show the results at both the division and brigade levels.

TABLE 4-1

DIVISION – COUNTS AND CASUALTY RATES BY MISSION (POSTURE)

	Division											
				Total		Mission (posture)						
						Defend		Attack		Reserve		
	Def./ offense TBC ratio	Def. rate	Off. rate	Count	Div TBC rate	Count	Div TBC rate	Count	Div TBC rate	Count	Div TBC rate
Total NATO	1.0	26.8	25.8	2,090	23.6	1,768	26.8	54	25.8	268	0.6
United States	1.0	25.9	26.7	710	22.0	583	25.9	31	26.7	96	0.3
Non-U.S.	1.1	27.1	25.2	1,380	24.1	1,185	27.1	23	25.2	172	0.7
Army A	1.0	29.3	28.3	917	26.3	806	29.3	15	28.3	96	0.5
Army B	1.0	25.4	25.3	1,037	21.8	832	25.4	36	25.3	169	0.7
"Created" Army	1.3	21.7	16.1	136	21.3	130	21.7	3	16.1	3	2.5
Day 1 to 10	a	22.7	a	290	17.5	214	22.7	b	b	76	0.3
Day 11 to 20	0.8	19.9	24.1	318	14.7	204	19.9	14	24.1	100	0.4
Day 21 to 30	1.0	30.0	29.6	340	24.9	254	30.0	19	29.6	67	1.5
Day 31 to 40	1.1	31.1	28.6	350	30.0	332	31.1	7	28.6	11	0.1
Day 41 to 50	1.6	29.4	18.1	368	28.6	352	29.4	10	18.1	6	0.4
Day 51 to 60	1.6	25.3	15.8	424	24.9	412	25.3	4	15.8	8	1.1

[a] Computation impossible.
[b] No observations.

[15]Nineteen divisions had each of the three maneuver brigades in a separate mission. We identified 10 as being offensive and 9 as defensive.

TABLE 4-2

BRIGADE – COUNTS AND CASUALTY RATES BY MISSION (POSTURE)

	Brigade													
				Total		Mission (posture)								
						Defend		Attack		Reserve		Cavalry		
	Def./off TBC ratio	Def. rate	Off. rate	Count	Bde TBC rate	Count	Bde TBC rate	Count	Bde TBC rate	Count	Bde TBC rate	Count	Bde TBC rate	
Total NATO	0.9	53.0	56.4	8,240	46.4	4,902	53.0	273	56.4	1,243	4.9	1,822	56.1	
United States	1.1	65.3	60.9	2,720	52.2	1,554	65.3	135	60.9	417	3.0	614	62.4	
Non-U.S.	0.9	50.5	54.2	5,520	44.9	3,348	50.5	138	54.2	826	5.6	1,208	54.5	
Army A	0.9	56.5	60.5	3,597	51.2	2,231	56.5	84	60.5	461	6.1	821	64.3	
Army B	0.9	50.3	55.4	4,123	42.7	2,319	50.3	183	55.4	753	4.2	868	52.7	
"Created" Army	1.8	47.8	26.3	520	44.4	352	47.8	6	26.3	29	7.1	133	40.6	
Day 1 to 10	[a]	41.8	[a]	1,150	32.9	615	41.8	[b]	[b]	321	5.3	214	44.1	
Day 11 to 20	0.7	36.1	53.8	1,262	27.8	576	36.1	72	53.8	396	1.1	218	37.8	
Day 21 to 30	0.9	55.3	58.5	1,350	47.0	711	55.3	94	58.5	272	3.8	273	59.8	
Day 31 to 40	1.1	61.4	57.9	1,390	59.4	926	61.4	56	57.9	69	11.5	339	66.2	
Day 41 to 50	1.1	60.4	54.6	1,446	58.7	975	60.4	28	54.6	81	14.2	362	68.6	
Day 51 to 60	1.1	56.4	50.3	1,642	53.4	1,099	56.4	23	50.3	104	9.6	416	56.4	

[a] Computation impossible.

[b] No observations.

At first, we were surprised to see that the NATO force is nearly universally on the defensive. Only about 3 percent of the simulation's division-days on the front line (54 of 1822 division-days not in reserve) are engaged in counteroffensive activity. About 5 percent of the brigade-days on the front line (273 of 5175 maneuver brigade days not in reserve) see such activity.

This minuscule proportion of offensive action does not accurately reflect the operations doctrine of the U.S. Army or of any Allied force with which we are familiar. All such forces emphasize the use of counterattack – at least up to the brigade level, with some nations admittedly stressing this more than others – as a major means of countering enemy forces, of "shaping" the enemy and keeping him off balance.

A single example may suffice to illustrate the inadequacy of the simulation's depiction of offensive (counterattack) activity. During the first 10 days of the Battle of the Bulge, the U.S. First Army – which was caught off guard, and the center of which was reeling backward before the German attack – managed to engage some 14 percent of its division-days in relatively intense counteroffensive activity. This percentage excludes those division-days devoted by Patton's Third Army to major counterattacks against the southern flank of the German salient. Only about 6 percent of the First Army's division-days were spent in a reserve status. (Significantly, however, some 35 percent of the Army's division-days were spent "fixed" on the front line without notably heavy combat activity.)

Nevertheless, when we first saw the data, we thought such a predominance of defense postures might indeed help explain why the simulation shows NATO units to take casualty rates much higher than the empirical evidence suggests. The conventional wisdom on defensive rates for losing defenders, after all, is that they will be roughly twice as high as rates for successful attackers. The fact that NATO forces are so fully on the defensive in the simulation – regardless of how militarily unsound that assertion may be – could go far to account for the unusually high rates.

However, the simulation shows the casualty rates of NATO units on the defensive and on the offensive to be virtually identical. The ratios of the defensive rates to the offensive rates, far from approximating the 2:1 rule so widely accepted, are usually 1:1 or in fact lean toward somewhat higher attacker rates.[16]

Clearly, posture along the front (i.e., defense versus attack) does not account for rates or patterns in the simulation. Figure 4-24 depicts proportions of division-days, for army-size forces over 10-day periods, spent in various operational postures. The only significant relationship between rates and posture is seen in the shift between front-line postures (defense or attack) and reserve status.

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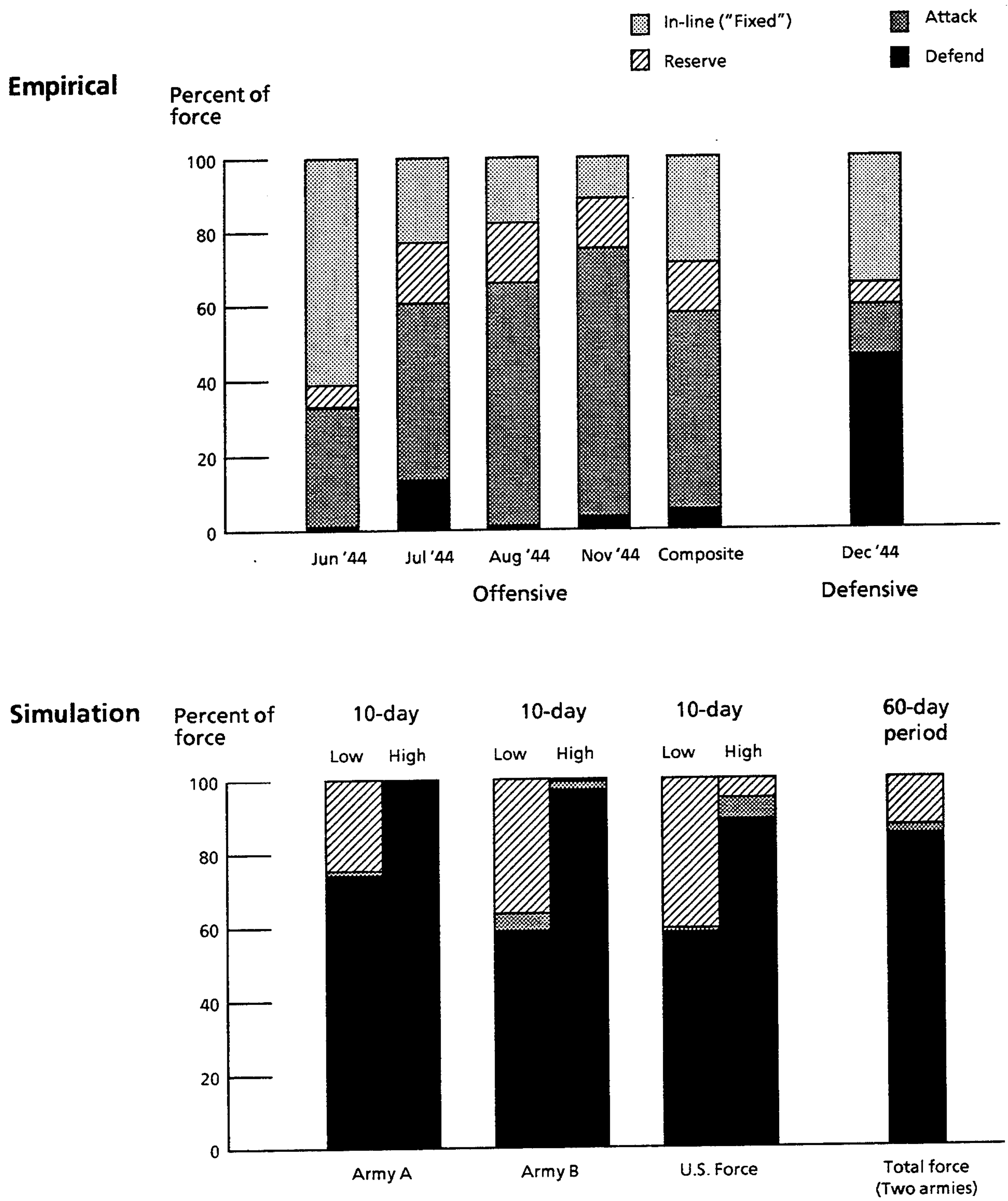
[16]The simulation also does not conform to the 2:1 rule in comparing the Warsaw Pact rates (Red) to its NATO defender (Blue) rates. If it did, the rates for Red attackers who so successfully push defenders back would be on the order of half the rates of those Blue defenders. Warsaw Pact rates are consistently higher than NATO rates – a fact we find credible enough, for reasons unrelated to any rule of rate ratios. Warsaw Pact rates are shown in Appendix B.



Note: Simulation (Omnibus 89) contained no "In-line (Fixed)" category. "Low" and "High" refer to low and high TBC rate periods.

FIG. 4-24. COMPARISON OF PROPORTIONS OF ARMY-SIZE FORCES BY POSTURE

HOLISTIC CASUALTY PATTERNS: OPERATIONAL-LEVEL RATES IN THE COMBINED TIME-LATERAL DIMENSIONS

General

The temporal and lateral dimensions in which we have so far compared simulated and empirical casualty rates must, of course, be rejoined into a single picture for a full comparison of actual versus simulated casualty rate experiences. The principal quantitative characteristic of this holistic perspective, in contrast to the other more partial perspectives, on casualty phenomena at the operational level of war is the sharply reduced proportion of peak-rate division days.

The pulses we have viewed in the two dimensions now manifest their full shape in the larger context: at the operational level of war the number of dramatically high casualty rate peaks is far overshadowed by the number of lesser casualty rate days across the full force.

The fact of rate pulses that exist in time for any unit combines with the fact these pulses exist at different times across a front for different units to produce an even more skewed distribution of rates at the operational level than we have seen is already a prominent characteristic of casualty rates at the tactical level. The fact that any given division will experience high rates for a minority of its overall time line – that is, that even a single division's rate distribution is skewed toward the high end – has greatly accentuated importance across an operational-level force for operational time periods.

Our continuing example of such a force and time period is an army-size force for at least 10 days.

We review three measures of these casualty rate events: peak 10-day TBC rates, the distribution (spread) of rates across the full force over the full period, and the composition of these rates in terms of the proportion of the force (percentage of division-days) found in the various rate classes. As before in this chapter, our focus is primarily on patterns. We return to the issue of rate magnitudes and their credibility after the next chapter in which Soviet operational approaches are considered. We also revisit, using empirical data, the subject of the distribution of division-days by posture (defense, attack, etc.) during peak periods.

Average TBC Rates

We first contrast the empirical data and the simulation data in terms of 10-day moving average TBC rates. Figure 4-25 shows both empirical and simulated sets of TBC rates. It shows the TBC rates for the U.S. First Army over the course of 9 months of combat in 1944-45 in Northwest Europe. This force experienced more and generally higher peak rate periods than did other army-size forces on the Western Front. The figure also shows the simulation's representation of army-level 10-day moving average TBC rates for a period of 60 days.

The simulation's rates are striking in at least two ways. First, the rates reach magnitudes (in the range of 30+/1000/day) simply never seen in continuous front settings for such force sizes and periods. (In Chapter 5, we discuss the Eastern Front to see whether and in what ways such rates might be reasonable in disrupted front settings against Soviet methods.)

Second, the simulation essentially produces no army-level pulses in the way the empirical data leads us to expect: relatively short, sharp pulses which recur over the course of a period as long as 60 days if significant combat continues. Instead, the simulation shows some high rates for a very few first days, then produces a dip in rates for some 15 days, and then represents the last 40 days as a single great pulse. As seen in Figure 4-25, this pattern holds for each army-size force and also for the total NATO force (two armies abreast).

The simulation's rates thus fail to meet a major test of patterns at the operational level: the presence of multiple pulses over a period as long as 60 days.

We now look at two further elements of this set of rates: distribution of rates across the force and the proportions of the force (in terms of numbers of division-size units) experiencing various rates.

Distributions of Force Rates

Previous figures have shown the daily distribution of rates across an operational-level front. As pointed out in some detail in our first report, empirical casualty rate data are clearly skewed strongly toward the high rates. That character of rate distribution is evident at all echelons, for 1-day tactical events as well as for 1-day operational-level experiences. When operational-level combat phenomena are

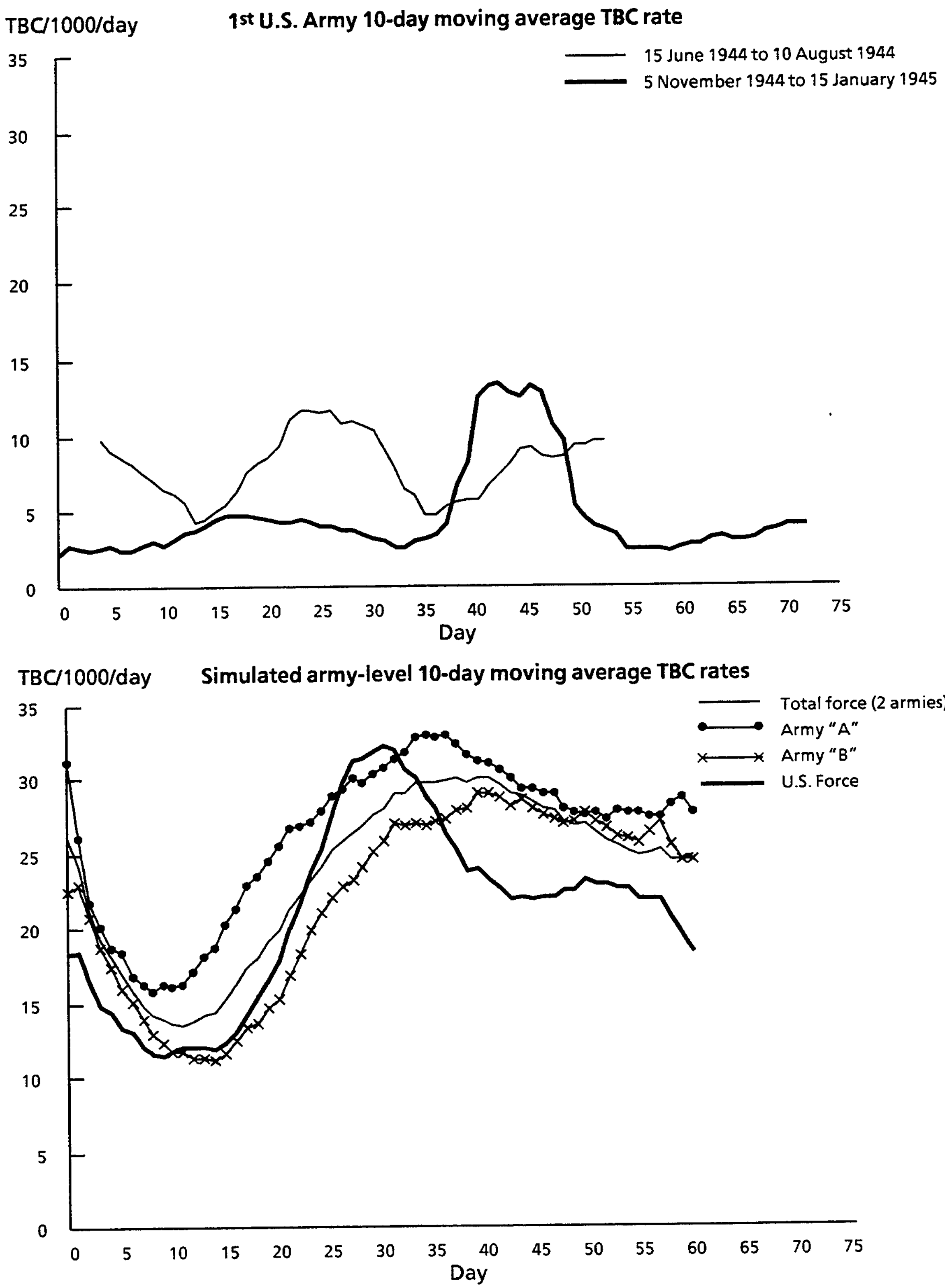


FIG. 4-25. 10-DAY MOVING AVERAGE TBC RATES

(Operational level of war)

viewed holistically – for operational-level time periods as well as force sizes – that distribution is even more pronounced.

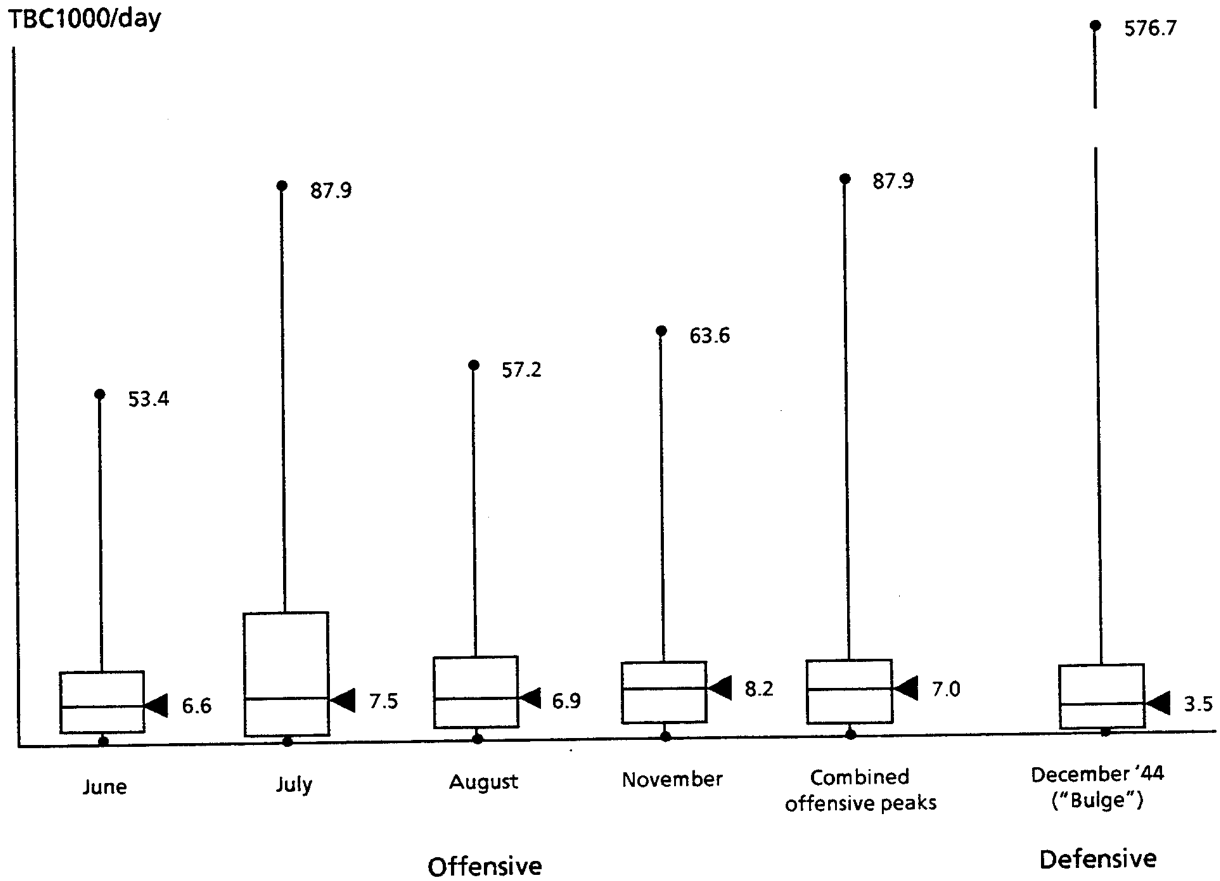
Figure 4-26 shows the distributions of rates seen in our five examples of rate peaks for army-size forces on both the offensive (with a composite of the offensive experiences also shown) and the defensive.[17] The maximum rates during the offensive periods range from 8-to-12 times higher than the median rates for the force. On the defensive that ratio is stunning indeed: 165:1. The difference is due both to the extremely high rates that will be experienced by a minority of the defensive force in the sector(s) of penetration and to an overall lower median force rate. Still, the key feature generally is the ratio in all cases between the maximum and median rates.

The set of simulation distributions of rates for army-size forces (and even for the entire NATO theater force) is shown in Figure 4-27. The comparison with the empirical data is again disappointing.

The simulation (Figure 4-27) shows significantly skewed distributions during the low-rate period only. Even here the ratio for one-army forces (Army A, Army B, and the U.S. force) between the maximum and median values is only about half that for actual forces on the offensive. In the case of the full NATO theater force during the low-rate defensive period, the simulation does succeed in achieving a maximum-to-median ratio that matches a set of such ratios for actual single armies – interestingly, those on the offensive.

However, the simulation fails to show significant skewness in precisely the situation in which skewness would most be expected: when the defenses are most heavily pressed. During the high-rate defensive periods, the ratios between the maximums and medians remain uniformly at about 3:1. That this ratio is lower than the ratio during the low-rate periods shows a tendency in the simulation that is exactly opposite what empirical evidence leads us to expect.

[17]Figures 4-26 and 4-27 show rate distributions by means of Tukey-style box plots. These display the maximum and minimum rates, the rates at the 75th and 25th percentiles of the distribution (shown by the upper and lower ends of the boxes, respectively), and the median rate (marked by the arrow).



Note:

Statistic	June	July	August	November	"Combined"	December
75th percentile	11.7	20.1	14.7	12.3	12.3	10.3
25th percentile	3.1	0.9	2.5	2.5	2.1	1.4
Minimum	0	0	0	0	0	0

FIG. 4-26. DISTRIBUTION OF DIVISION TBC RATES FOR ARMY-SIZE FORCE OVER 10 DAYS
(Empirical evidence – peak period rates)

Proportions of the Force by Rate Class

Figure 4-28 takes the five highest 10-day rate periods on the Western Front and displays them in terms of the percentage of the force that fell into each of three rate classes. The periods are also displayed by offensive and defensive posture. (We have as well combined the four offensive periods into a single composite offensive period.)

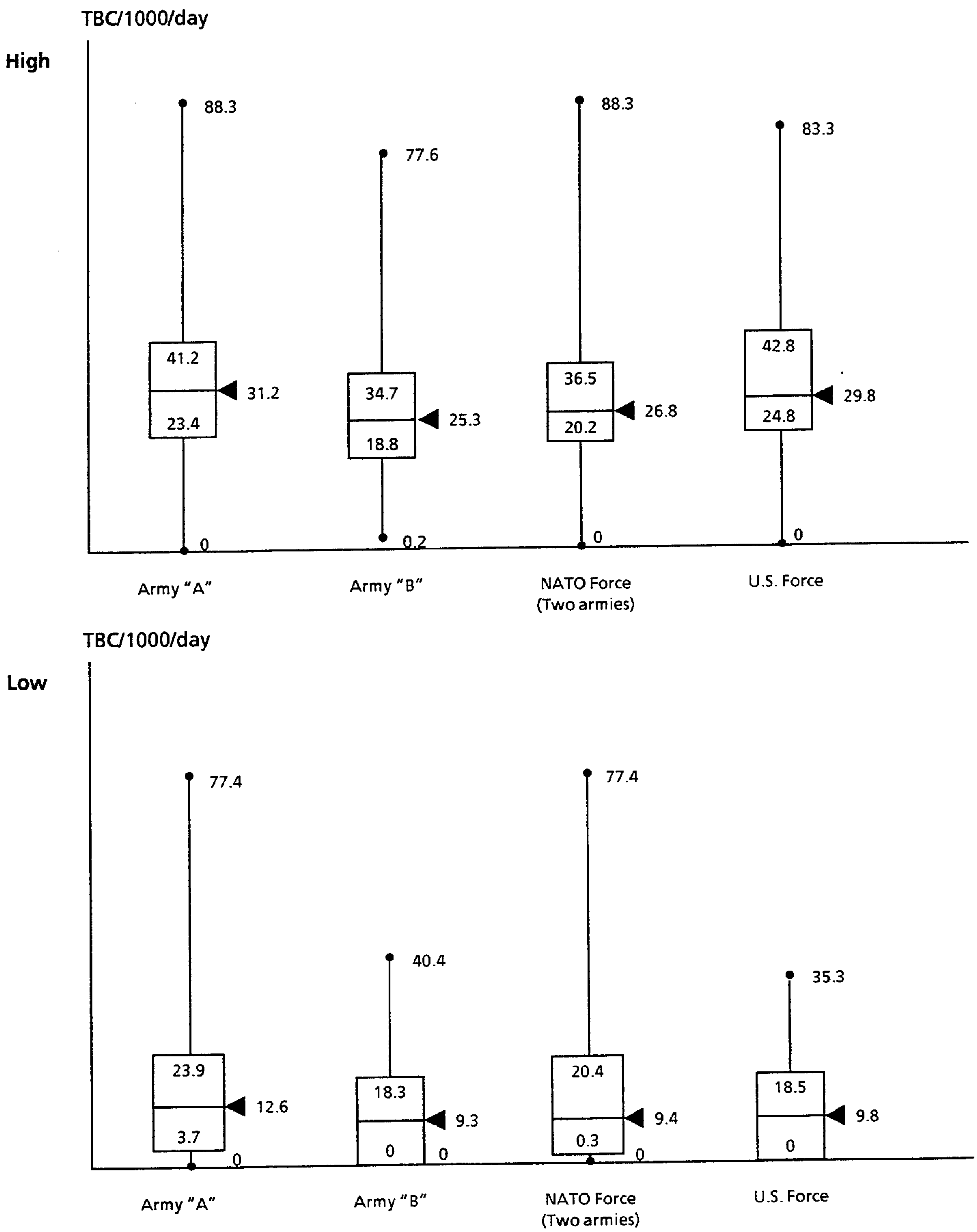


FIG. 4-27. DISTRIBUTION OF DIVISION TBC RATES FOR ARMY-SIZE FORCE OVER 10 DAYS

(Simulation – high and low period rates)

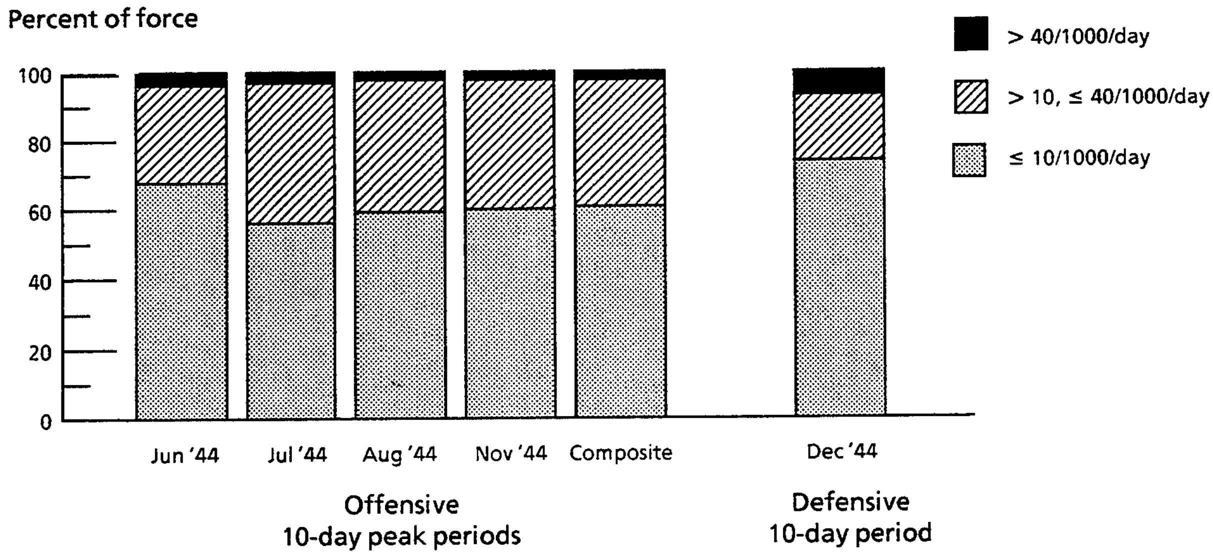


FIG. 4-28. PERCENT FORCE PER RATE CLASS – EMPIRICAL

The figure suggests that the proportions of the force found in the rate classes is strongly associated with posture. The four offensive peaks have roughly similar proportions, while the defensive peak is noticeably different. The differences may be summed up this way: compared with the defensive posture, the offensive peaks show lower proportions of the force in both the highest and lowest rate classes and higher proportions in the middle rate class. Where the defensive peak has only half the proportion of force in the middle class as do the offensive peaks, it has over 20 percent more in the lowest class than the composite offensive peak and over 160 percent more in the highest class of rates.

While the proportion of the defensive peak's force in the highest rate class is greater than the force proportions in that class during offensive peaks, that does not mean that the high-rate proportion is large relative to the overall force size during any type of peak. Rather, the proportion of force in the highest rate class is in all cases small. This small size makes this highest rate class quite sensitive to even the comparatively small increases in numbers seen when moving from an offensive setting to a pressed defensive setting.

This sensitivity of the highest rate class is another reflection of the highly skewed nature of empirical rate distributions in general toward the high rates. The

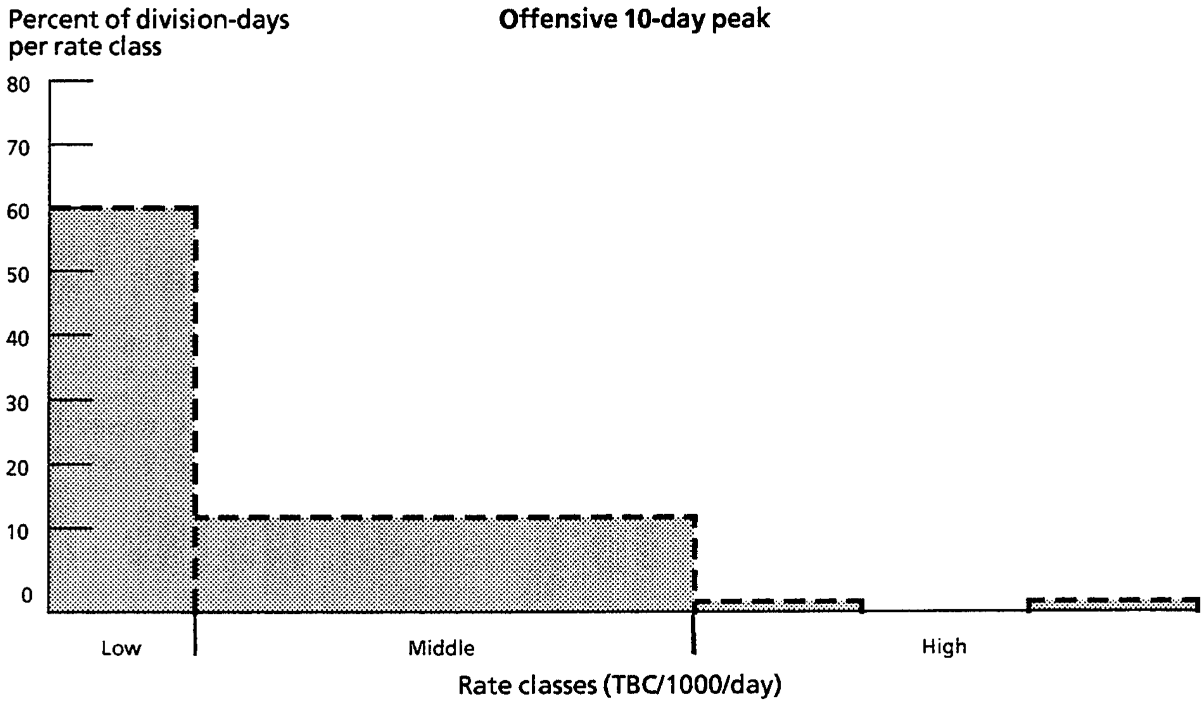
corollary to this observation is that the lowest rate class holds over half the total force in all cases.

Figure 4-29 shows in a notional way what might be termed the movement of the probability mass of the rate distribution when going from an offensive to a defensive peak 10-day period at the operational (army-size force) level. Where the offensive period shows a greater likelihood of observations in the middle rate class, the defensive period shows a distinct decline in that middle area and simultaneous increases in observations in both the lowest and highest rate classes.

The increased masses of observations at the ends of the rate class spectrum probably result from the defending force simultaneously experiencing heavy attacks in relatively narrow breakthrough sectors and an increase in the relative proportion of the force's overall frontage rendered less active than is the case when the force is on the offensive and thus more "in control" of events along that front. In any event, the defending force will experience significantly heavier casualty rates among some larger portion of the force structure than is the case when on the offensive. The size of that increase will depend – as discussed in Chapter 5 in terms of disrupted fronts – on what happens in both the attacker's penetration sector(s) and, if the attack is successful, in the exploitation area(s).

A general observation may be made on this evident character of the weight of division-day rate experiences across the spectrum of rate classes. All periods of operations, whether offensive or defensive, will see a distribution of observations that is skewed toward the high end with most observations in the lowest class. However, offensive periods will see relatively greater weight in the mid-range class, with extremely few observations on the higher end. Periods when the force is thrown on the defensive will see the spectrum's high and low ends both increase – at the expense of observations in the mid-range class – with the greater relative growth seen in the higher class (because of its always-small size).

We turn now to the composition of the simulation's set of division-day observations across the spectrum of rate classes. We note that the simulation represents a defensive setting that gradually – as indicated by the rates – grows worse. Without reference yet to the credibility of the simulation's rate magnitudes, we would expect the simulation's 10-day peaks to resemble at least roughly the empirical evidence of the composition of a defensive peak – with relatively heavier



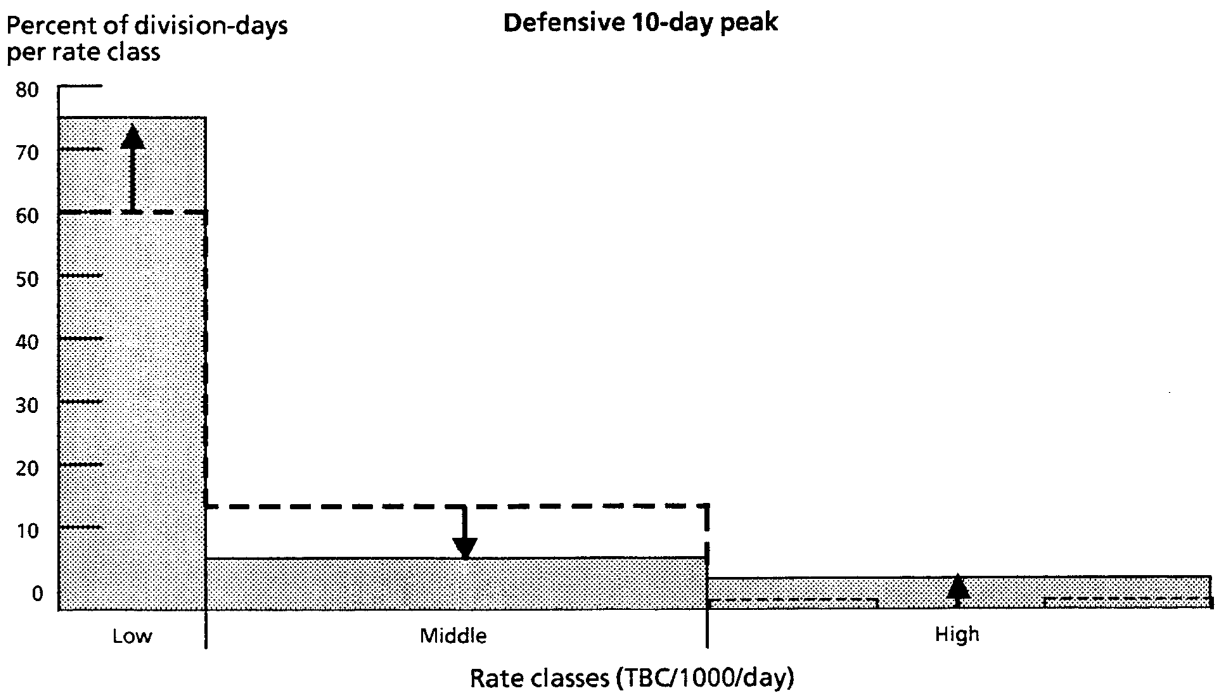


FIG. 4-29. CHANGE IN NOTIONAL PROBABILITY MASS OF RATE DISTRIBUTION FOR ARMY-SIZE FORCE GOING FROM OFFENSIVE TO DEFENSIVE 10-DAY PEAK

weights in the high and low classes. Since the simulation represents friendly army-level forces only on the defensive, the motion of the observations into the ends of the rate class spectrum should at any rate follow the worsening defensive situation. Figure 4-30 shows the simulation's proportions.

Once more, the simulation's force proportions present an entirely different picture from those seen in the empirical data. First, the highest class of rates is large by any standard; further, it grows to 15 to 20 (and more) percent of the force, which is 2 to 3 times the proportion seen in the empirical defensive peak in Figure 4-28. Meanwhile, rather than growing, the lowest class drops from almost half the force to 10 percent and less. And where in the empirical data the proportion of the force in the middle rate class drops by half when going from an offensive to a defensive peak, the simulation – which, again, depicts a worsening defensive scenario – shows the middle class *growing* by roughly 50 to 100 percent.

SUMMARY

A review of the simulation's casualty rates from the full perspective of the combined time and lateral dimensions repeats and, in fact, deepens our concern about the same kinds of difficulties the more partial individual perspectives introduce. Whether the focus is on rate pulsing and variability in time or across the front, on the character of rates as a function of force posture, or on the manifestations of all such considerations in rate distributions for operational-level forces, the simulation's results are the same: distinctive rate patterns tied to force sizes, time periods, and settings are washed out and replaced by a set of rate patterns that in their uniformity are counterempirical. The salient features of the underlying quantitative patterns of real-world casualty rates are nearly nonexistent for the simulation.[18]

The question that remains is whether the rates projected by the simulation might somehow, nonetheless, be found credible. The focus shifts now to scenarios that might indeed support such rates as the simulation projects.

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[18]As noted in Chapter 2, other runs of the simulation show results that differ from those of Omnibus 89. Thus, analysis of their underlying quantitative patterns would show certain differences from those in Omnibus 89. For example, analysis of rate curve shapes would show a falloff in lag rates following a Day x rate. However, the critical point is that such falloff would *not* owe to a pulsing and variability of rates – as is the case in the empirical data. The falloff would derive instead from the very uniformity of rate behavior in the simulation we have described in this chapter.

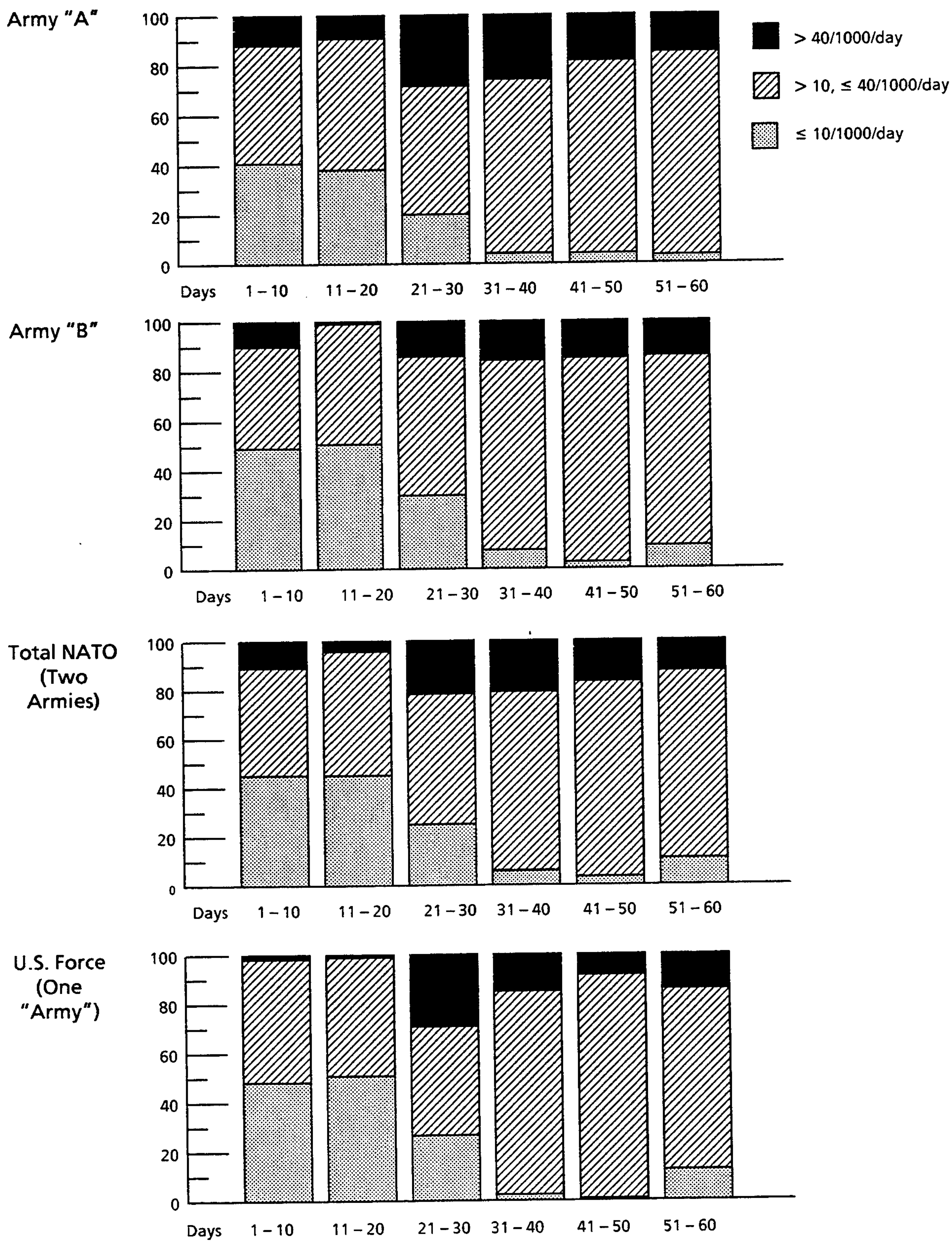

FIG. 4-30. PERCENT FORCE PER RATE CLASS – SIMULATED

(All periods defensive)

CHAPTER 5

PATTERNS OF OPERATIONS: OPERATIONAL-LEVEL CASUALTY RATE SCENARIOS

GENERAL

Thus far, our discussion of casualty rate data has focused on quantitative measures of casualty rates as seen in patterns of rates. Those patterns themselves, however, reflect certain generally definable operational scenarios or settings.

In the first report, we described our finding that operational-level casualty rate events occur in what may be termed continuous or disrupted front scenarios. In this chapter, we first briefly review that earlier discussion of front types and then describe new findings from further research on German experience against Soviet methods. That extended research now permits us to distinguish several kinds of disrupted front, and component aspects to disrupted front experiences.

Chapter 6 then compares the Army Staff simulation's output to kinds of empirical rates associated with these broad scenarios – continuous and disrupted fronts – and certain of their constituent elements.

CONTINUOUS AND DISRUPTED FRONTS

We have defined continuous and disrupted front scenarios.[1] A continuous front is that situation in which the operational-level frontage retains its overall integrity, or cohesion. The enemy cannot take decisive advantage of temporary weaknesses before they are shored up or eliminated.

In most cases, an attacker's front remains continuous. Others have observed that in most cases the attacker wins. In any case, however, the attacker is the initiator and, unless severe reversals are combined with the enemy's ability to exploit them, even a loss will not usually throw an attacker's frontage into disarray.

A defensive frontage may also remain continuous. A defender who wins, or at least does not lose sharply, will retain the basic cohesiveness of his frontage. Much of

[1]In Chapter 8 of our first report, pp. 8-3 through 8-7.

the German frontage during the Western and Eastern Front action in fact remained continuous, even though they were withdrawing. A worst-case continuous front would be one in which the defender loses ground rapidly and confusion is high but the defender is able to stabilize the situation before the energy of the attack carries large forces past the defender's protective measures and into rear areas. The U.S. Ardennes defensive front appears to be an example of a worst-case continuous front.

A disrupted front is one where the defender in essence has his front broken – chunks removed, as it were – in one or more places, and finds major operational-level enemy formations in the rear areas. The Allies in the West never experienced such a scenario. The Germans experienced it in the West during the Allied breakout, and numerous times in the East against the Soviets. The Soviets experienced it against the Germans early in the war and as late as early 1943.

We reported previously that 10-day division average TBC rates for army-size forces would probably not exceed 9-to-14/1000/day[2] for a continuous front scenario, but would jump to something around 18-to-20/1000/day (and perhaps somewhat higher) for disrupted fronts. Subsequent research into German experience on the Eastern Front provides a fuller insight into rates for disrupted fronts.

Although the picture is more complex than it previously seemed, we believe we can now identify the keys to the high disrupted-front rates.[3]

NEW FINDINGS

Several new insights have emerged. Critical insight into the operational features of continuous fronts was gained in the matter of the shifting proportions of division-days in an army-size force spent in different classes of casualty rates in accordance with changing overall force postures. We describe these shifts in Chapter 4 (pages 4-31 to 4-34).[4]

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[2]The rate cited in our earlier report was 10-to-13/1000/day. Subsequent review of the data suggests the endpoints may actually be somewhat closer to 9 and 14/1000/day.

[3]Our research on the patterns and rates of disrupted fronts continues. Further findings will be incorporated into our third report.

[4]See Figures 4-28 and 4-29, and compare with Figure 4-24 (empirical). The indicated shifts in rate class proportions found in continuous front peak rate periods would appear to be only more dramatic in disrupted front (especially higher-order) scenarios.

The main thrust of the new insights, however, is that rates for disrupted fronts may be either considerably higher or considerably lower than previously thought. It now appears disrupted fronts may sometimes exhibit rates akin to continuous front rates, although in most cases the rates for disrupted fronts will indeed rise substantially beyond those for continuous fronts.

The major key to different rate experiences along disrupted fronts lies in whether the attacker succeeds in catastrophically encircling or overrunning major portions of the defender force. The distinctly minor key to higher rates is the number of breakthrough sectors, or what may be termed their extent.

Our previous research revealed no German army-level 10-day rates higher than 19/1000/day, and only one instance of a rate that high. The Lvov-Sandomierz defensive was a German defeat of major proportions, and our database contains quite extensive data on that action. The rate of 19/1000/day, experienced in the first 10 days, was occasioned by a situation – an entire corps in the center of the German line virtually disappearing – dissimilar to any situation experienced by the Allies on the Western Front. The sufficiency of the data and distinctiveness of this scenario combined to define the kind of setting that could indeed produce rates as high as those the U.S. Army Staff's simulations had for several years shown for an army-size force for peak rate 10-day periods.

We noted in our previous report that the single factor most responsible for taking the U.S. 1st Army's 10-day rate for the initial Ardennes defensive period to the height of 14/1000/day was simply the losses sustained by one division, the 106th Infantry. Without that division's extraordinary losses, the army rate would have been about 10/1000/day, a rate indistinguishable from the higher rates sustained in offensive operations earlier in 1944. We also noted that if during the breakthrough one or two additional divisions had simultaneously duplicated the experience of the 106th, the army rate would have risen to something in the area of 16-to-20/1000/day, which would appear to parallel the German rate during Lvov-Sandomierz. Our focus in the first report was therefore on the breakthrough sector per se.

We failed, however, to recognize that the deeper parallel between the Lvov-Sandomierz and Ardennes defensives might, after all, rest in the occurrence or the

absence of catastrophic encirclement (or overrunning) of some portion of the defensive force. In the German case, two breakthrough sectors soon yielded a major encirclement – of a corps-size element of some five divisions, or roughly a quarter of the defensive force in the actual operations area (i.e., not including the less engaged far flanks). Those five particular divisions began the period with an average strength of more than 11,000 soldiers each and ended it with something in the range of 4,000 or fewer each. It would appear, given the structure of the divisions and their personnels' deployment, that the combat elements of the divisions essentially disappeared. Such was precisely the case with the U.S. 106th Infantry Division, which went from a strength of more than 13,000 to less than 5,000 in 4 days. The 106th Division's losses over the period were due in part to heavy 1-day losses reported on the second day in the breakthrough sector but much more importantly to the encirclement and sudden surrender of two of the division's three regiments on Day 4.

In both these Soviet-German and German-American instances, the breakthrough sector sustained heavy but sustainable defender losses from the initial attack. In each instance also, a major portion of the defensive force was rapidly and catastrophically encircled during the attacker's exploitation of breakthroughs. In the Ardennes, only one U.S. division fell victim; in Lvov-Sandomierz, an entire German corps fell victim. In the former, the army-level front remained continuous even though pressed hard; in the latter, the front was disrupted.[5]

COMPONENT ASPECTS OF DISRUPTED FRONT RATE LEVELS

As the importance of distinguishing encirclement from breakthrough rates became clearer, the fact that we could discern component parts to the disrupted front experience also began to emerge. Our continuing research on the German Eastern Front experience also now indicates that disrupted front rates on the whole seem to occur in certain rate strata or levels. We now turn to discuss these related insights

[5]Terrain played a critical role in the differences between the casualty rate results in these operations. The Ardennes terrain restricted the attacker's ability to move rapidly and deeply along multiple axes of advance, while the terrain in the Soviet Union permitted exactly that kind of mobility.

about component aspects of disrupted fronts and the rate levels into which disrupted front experiences fall.[6]

The research reveals what presents itself to be a series, or set of levels, of increasingly worse scenarios involving disrupted fronts. It has become clear that the severity of rates in breakthrough sectors themselves can range from extremely high to surprisingly low. The more decisive aspect of disrupted front rates, however, is the subsequent defender experience: Is a substantial part of the defensive force quickly surrounded or (amidst confusion) overrun during the exploitation of the breakthrough, or do the defenders succeed in pulling back rapidly before the spearheads to defensible positions (often, but not always, to include offering significant resistance during such a withdrawal)?

The level of rate severity in a given disrupted front appears to arise from the combination in that particular case of several kinds of combat results along the front. The first question is whether the breakthrough occurs in one or more places, and whether the defending force at the point(s) of breakthrough suffers catastrophic or only relatively light casualties. Perhaps surprisingly, the latter seems to occur as frequently as the former.

The defender in the penetration sector will suffer catastrophic casualties when the force as a whole is penetrated before being able to withdraw. Most of the Eastern Front German data on these occurrences are lost. Those that remain confirm Western Front U.S. data that show most of these casualties are derivative (missing and captured) rather than direct (killed and wounded).[7]

Whether the defender in the breakthrough sector – better, what proportion of the defender in such a sector – suffers catastrophic casualties depends largely on the

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[6]This extended research has required going beyond the data that are strictly available in our German database. The effort has been to define rates that possibly occurred, especially at the Army level, by adding to the data-on-hand rates that have been imputed for certain divisions for which in fact little or no data remain. This has permitted a larger analytic framework to develop. A key test of the adequacy of that framework has been whether the framework accommodates those actual data that are available. As pointed out in our earlier report, the extant data include significant numbers of cases of divisions across the entire spectrum of combat phenomena (catastrophic rates in breakthrough sectors, catastrophic encirclement, reserve divisions combatting breakthrough forces, rates along the rest of the front, etc.). We have sought and received the expert and invaluable assistance of the U.S. Army's Soviet Army Studies Office (SASO) for this extension of our study.

[7]Discussed in Chapter 8 of our earlier report, pp. 8-7 to 8-10.

size of the sector being considered.[8] The evidence seems clear that catastrophic casualties are generally limited to a width of front of no more than *one or two regiments*.[9] This focused tactical sector may be a single regiment out of one division, or one regiment each from two adjacent defending divisions. Some of the most effective disruptions of German army-level defensive formations resulted from the collapse of one or two such single regiments.

Usually, however, the penetration sector extends beyond this tactical focus area. This broader breakthrough sector has a correspondingly lower likelihood of catastrophic casualties across its full width. A successful attack in this broader, operational penetration sector will probably witness a catastrophic penetration of the narrow tactical frontage just described, plus the rapid withdrawal of most if not all of the rest of the defending force.

The form of that forced withdrawal seems almost invariably not to be straight backward before the advancing attackers, but is instead a curling motion away from (along the shoulders of) the tactical attack corridor. This withdrawal motion is undertaken by the defenders in the operational breakthrough sector to improve their tactical position. Its effect both reduces their casualty rate and, more important to the attacker, opens the front to disruption. Where the operational penetration sector as a whole is wider than its point of tactical focus, a smaller portion of the defending force may suffer a catastrophic result and a larger portion takes relatively lighter casualties while it turns aside.[10]

In all cases, the proportion of the overall army-level force that takes catastrophic casualties in the breakthrough is small. The severity of the operational-

[8]Defender loss rates also, of course, depend on what may be termed the "energy" of the attack. This additional consideration comes more into play with the other kinds of disrupted fronts, discussed subsequently.

[9]In Soviet parlance, this particular portion of the width of the penetration sector represents the point of tactical focus inside the "operational direction," which in turn stands inside the "strategic direction." When Soviet-German force ratios across the strategic front (equivalent to today's Central Front in Europe) approached 2:1, mature Soviet operational methods succeeded in reaching ratios at this tactical focus in the range of 8-to-10:1.

[10]The East Prussia defensive, for example, found some 6 or 7 defender divisions in the southern breakthrough sector. However, these divisions were badly understrength and occupied unusually narrow frontages.

level defender casualty rate turns far more on the character of events during the exploitation.

A successful penetration will be followed by an exploitation phase. From the attacker's perspective, the exploiting forces will cover some portion of the defender's area. That coverage may go along narrow penetration lines that in turn may either bend to surround or encircle defensive forces or go deep into the defender's rear. The coverage may also expand in a wedge that may or may not include some encircled or overrun defenders.

From the defensive perspective, a successful breakthrough along the army-level front may be followed either by a fairly rapid and effective withdrawal (i.e., one that also resists and slows the exploitation forces), by the attacker's effective encirclement (or overrunning) of a portion of the defending force, or by some combination of withdrawal of some forces and encirclement (or overrunning) of others. Again, the defender's overall army-level rate during a disrupted front will depend far more on which of these latter possibilities occurs (and to what portions of the defending force) than on the rate at the point(s) of penetration.

In every operation studied, the German rates along the "rest" of the defensive frontage – those portions not targeted by Soviet forces for penetration and not encircled or overrun as a result of breakthrough – were wholly consistent with rates on the Western Front for Allied divisions not located in penetration sectors. Again, what we found surprising was that even in penetration sectors, some divisions had relatively low rates despite major breakthroughs by enemy forces.

The key, then, to ascertaining levels of rates for disrupted fronts is to ascertain the likely combinations of several linked kinds of rate experience: in breakthrough sectors, in the exploitation area (including the rates for the defender's operational reserves committed against exploitation forces), and meanwhile across the rest of the front.[11]

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[11]Our German data include numerous cases of mobile (panzer and panzer grenadier) divisions thrown against Soviet exploitation forces. The rates for these German divisions of course vary, but are mostly consistent with Allied rates on the Western Front.

EXAMPLES OF DISRUPTED FRONT RATE LEVELS

The possible combinations of the component parts to a disrupted front rate experience may be illustrated practically. The following examples focus on rates for German army-size forces for 10-day periods in four kinds of disrupted fronts in terms of rate severity levels.

The first kind of disrupted front may be illustrated by the German Kharkov and Donbas defensives in early 1943. In this kind of disrupted front, a major breakthrough has occurred to force the defenders to pull back, but the attack is contained. In these particular cases, the Germans actively overcame the attacking force and either fully or largely restored the line.

The distinguishing feature of this first kind of disrupted front is an exploitation phase which does not witness serious encirclement. At Donbas, two German divisions were briefly encircled but were able to extricate themselves quickly in the fluid situation; thus, their casualty rates had minimal impact on the 10-day operational rate.

This first level of disrupted front is quite similar to a worst-case continuous front situation. Rates may rise to the level of 9-to-14/1000/day for an army for 10 days. They may also easily be lower. A critical aspect of the scenario at this first level of disrupted front is the fact of low force density on both sides. That is, the fluidity of these operations was associated largely with the low density of forces facing each other. This low density is an aspect of certain earlier Eastern Front operations not seen in the later, more mature Soviet offensives.[12]

It is conceivable that rates in cases of this first kind of disrupted front could rise somewhat higher than, say, 14/1000/day. Such an increased rate would accompany cases in which the breakthrough sector is more extensive than was the Ardennes sector. As noted above, we discussed in our first report how such rates might reach the range of 16-to-17/1000/day – if two divisions simultaneously, rather than merely one, experienced catastrophic rates in the breakthrough sector(s). The rate could reach 20/1000/day if three divisions simultaneously experienced such rates.

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[12]Since the density of forces along a front may be an increasingly important consideration for the European theater in the 1990s and beyond, we will return to this consideration in our concluding report.

This possibility of higher rates associated with this first level of disrupted front seems, however, highly unlikely. A scenario in which the breakthrough is so massive strongly tends to fall into one of the three higher levels of disrupted fronts. These higher levels all exhibit this feature: major and catastrophic encirclement (or overrun).

The next higher step in the series of disrupted front scenarios is represented by the Lvov-Sandomierz defensive of July 1944 (cited above and in our first report).[13] Two breakthrough sectors – one in each of two adjacent German armies, neither of which resulted in catastrophic rates to more than regimental elements – led to the quick encirclement of a corps-size force. The rate of the German army that lost four of those five divisions was 19/1000/day. That rate indicates an army in defeat. Whether such an army can fight effectively again depends on many particulars, such as whether it has time to rebuild or at least to redeploy effectively.[14]

An important note here is that the same curling motion by defender forces away from the attack corridor – mentioned above with regard to tactical forces in the breakthrough sector – is seen at a higher level of operations in the Lvov-Sandomierz campaign. The rate of 19/1000/day cited for this campaign is actually the rate for the German 1st Panzer Army in the Lvov/Kovel *portion* of the larger campaign. The encircled corps-size force formed the famous "Kovel Pocket." At the same time, however, the main action continued to the north – toward Sandomierz – as the 4th Panzer Army curled away from the breakthrough sector now greatly enlarged by the lost pocket. The rates for the 4th Panzer Army during the remainder of the operation (which was fluid and ran deep into the German area) were those of a first-

[13]The Belgorod-Kharkov defensive of August 1943 might also be mentioned as a first example of penetration with following encirclement. The penetrating Soviet forces succeeded in encircling three German divisions, which however soon escaped the encirclement. This degree of encirclement is relatively minor and does not lead to appreciably higher overall army-level rates (even though the three divisions sustained significant losses). In fact, this campaign shares aspects of both first- and second-level disrupted front scenarios. There is some degree of encirclement – of a small-corps size force – but the encirclement is far from catastrophic. The casualty rate is that of a first-level disrupted front.

[14]The Germans had such opportunities on the Eastern Front for many reasons. Among them was that front's great depth and the general recuperative excellence of German forces. Also, in most operations Soviet offensive energy was spent in the major (even though successful) offensive effort. It must be remembered that even greatly successful offensives come at significant cost to the victor. (The Soviets are just now beginning to publish their own casualty figures in more or less systematic fashion.) Attacker losses and cohesion in turn largely determine whether operations beyond the breakthrough and exploitation can be sustained with the requisite energy and effect.

level disrupted front. The rates for the 1st Panzer Army, by now effectively bypassed by the course of events, similarly fell into the lower range for the subsequent period.

The third of the four types of disrupted front rate levels is still higher on this ladder. It consists of those actions in which the defender force suffers massive defeat through the loss of the equivalent of multiple corps. The premier example of a third kind of disrupted front is the German defeat during the Vistula-Oder campaign.[15] This Soviet campaign has until quite recently been the exemplar of the sort of campaign Soviet planners would seek to emulate.[16] Soviet forces quite simply tore through German lines in three major breakthroughs and proceeded along three parallel axes to astonishing depths (300 and 600 kilometers). Two of the advancing axes caught, in the physical area between them, some 14 German divisions. Seven of these effectively encircled divisions never returned, while seven others (some only remnants and all seriously depleted) eventually escaped.

The distinctive feature of the Soviets' Vistula-Oder campaign was its sheer power. The Soviets managed to build a strategic force ratio (about 5:1) of over twice that achieved in most other successful disruptions (averaging slightly less than 2:1). Whereas force ratios in the tactical breakthrough sector in those other disruptions were on the order of 8-to-10:1, this time they reached 16-to-17:1. German losses in the breakthrough sectors were catastrophic across full divisions. The strength of the Soviet force was such that the Soviet command's interest was not on encirclement per se but was on deep penetration. The penetrations broke through so completely, and the large forces raced forward on parallel axes so easily, that the 14 German divisions were simply caught and left behind as "floating pockets."

The German army-level rates appear to have reached about 32/1000/day for the peak 10-day period and perhaps 15/1000/day over 23 days.

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[15]Again, another example might be named. The German reversal in the 1942 Middle Don campaign saw severe losses among the Italian contingent. The rate across these divisions was just over 30/1000/day for a 13-day period. Two of nine divisions suffered catastrophic casualties in the breakthrough sector, while four others suffered only somewhat lower casualties during the ensuing exploitation. However, these latter losses were probably less due to the nature or form of the attack than to already existing internal weaknesses that led to the near-total breakdown of command and control which, on top of terrible logistics weaknesses, left these troops open prey to overrun by advancing attackers.

[16]The much-publicized Soviet turn in the late-1980s to a "defensive" strategy and operational approach marked the point at which the Vistula-Oder campaign is supposedly now of reduced importance.

The two highest examples we found of defender rates from the successful application of Soviet operational methods were the remarkable campaigns of Yassy-Kishinev and Belorussia.[17] At Yassy-Kishinev in August 1944, the Soviets broke through two less-well prepared (because of successful Soviet *maskirovka,* or deception, techniques) flank sectors and completely encircled an entire German army. In the Belorussia operation that same summer, a force of more than three Soviet *Fronts* broke through a three-army German line at six breakthrough points. The attack quickly succeeded in catastrophically encircling first a normal corps (four divisions) and soon another corps plus most of a third (seven divisions) during the first 10 days, and then continued over the following 10 days to the catastrophic encirclement of an entire army (four corps, or some 14 divisions).

At Yassy-Kishinev, 16 German divisions disappeared en masse. These losses were in addition to the catastrophic rates suffered by several divisions in the two breakthrough sectors. The campaign ended in 10 days. In Belorussia, a total of 29 German divisions disappeared in the successive encirclements (plus the break-through sectors) over a period of 3 weeks.

The army-level rate in each operation, measured over the 10-day peaks, was probably in the vicinity of 48/1000/day at Yassy-Kishinev, 36/1000/day during the first 10 days of Belorussia and 70/1000/day for the now-reduced force during Belorussia's next 10 days. Belorussia, then, had the character of a third-level disrupted front for its first 10 days and then took on the character of a fourth-order disrupted front over its next 10 days.

Consistent with our earlier findings on the distribution of tactical (1-division/1-day) rates, we found these higher operational-level rates to be distributed thinly over a greater range. This spread of rates in the highest class of disrupted fronts is far larger than the spreads between rates seen in the lower classes. This fact repeats at the full operational level of war the skewness (toward the high rates) of the set of rates seen for 1-division/1-day experiences on the Western Front. Of course, this skewness also denotes the rarity of these highest rates.

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[17]It is difficult to rank Stalingrad, which in terms of total numbers lost parallels the Yassy-Kishinev and Belorussian campaigns but did so over a much longer time span. The East Prussian campaign of early 1945 is also difficult to rank. It showed low (first-order disrupted front) rates during most of its course; then, at its end, some 34 German divisions (which had long been encircled without remarkable casualty effect) were suddenly lost.

SUMMARY AND RATES

Disrupted front experiences appear to fall into four levels of rates. Table 5-1 displays these levels, from highest to lowest, with their associated types of disrupted front.

TABLE 5-1

DISRUPTED FRONTS

Level	Defending force sizes witnessed[a] (no. of armies)	Distinguishing operational feature	Peak 10-day rates witnessed (per 1000 per day)
DF-4	1-to-2(+)	Catastrophic encirclement of army-level forces	~48, ~70
DF-3	1(+)	Catastrophic and near-catastrophic encirclement of multiple corps	~32, ~36
DF-2	1	Catastrophic encirclement of a single corps-size force	19
DF-1	1	No major encirclements	≤ 9 – 14

Note: By definition, all disrupted fronts have experienced one or two major breakthroughs per defending army-size force, with major (corps-level or larger) enemy forces exploiting the breaks before the defensive line is restored.

[a]An army-size force would range usually from 10 to 15 divisions, but could be as few as 8 for smaller operations or up to 18 or 22 divisions in the larger-scale operations.

The key to where an operational rate falls along the spectrum of disrupted front rate levels is the particular combination of three major component combat phenomena in the instance: the penetration sector experience (especially whether catastrophic losses are incurred);[18] the exploitation phase (especially whether the exploitation successfully encircles forces catastrophically and in what proportions, plus the rate experience of operational reserves thrown against the penetration); and the proportion of forces along the remainder of the front.

Disrupted fronts are distinguished from continuous fronts. Continuous fronts may refer to an operational-level force's experience in either a defensive or offensive posture. The distinctive feature of a defensive frontage is that no such breakthrough

[18]As stated above, a front's disruption may begin with penetration sectors each witnessing either catastrophic loss to one or more regimental-size elements (in very rare cases, to full divisions), or losses of that character to force elements of that size plus far lower loss rates among the remainder of units in the sector, or only relatively low casualty rates throughout the penetration sector.

is experienced as permits major (corps-level or larger) enemy forces to operate in friendly rear areas before the defensive line is restored. Such a front may experience significant attrition and consequent withdrawal(s), or it may experience tactical breakthrough(s) with consequent withdrawal(s). The withdrawal(s) may be rapid and marked by confusion and may cover a major portion of the front. However, the enemy does not exploit the defense with major forces before the defense's integrity is restored. Table 5-2 shows peak rates observed for continuous fronts.

TABLE 5-2

CONTINUOUS FRONTS

Type	Force size[a] (no. of armies)	Time period (days)	Peak 10-day rates witnessed[b] (per 1000 per day)
Defensive	1	10	14
Offensive	1	10	9, 10, 11, 12

[a] An army-size force would range usually from 10 to 15 divisions; however, it could number as few as 8 divisions, or up to 18 or 22 divisions for larger scale operations.

[b] If the force size were to increase significantly beyond one army – say, to a force of 36 to 50 divisions – the associated peak 10-day rates would decline significantly.

CHAPTER 6

COMPARISON OF U.S. ARMY SIMULATION RESULTS WITH THE EMPIRICAL EVIDENCE AT THE OPERATIONAL LEVEL OF WAR

GENERAL

In this chapter, we compare the Army Staff simulation's casualty rate results against the sets of rates and scenarios the empirical evidence provides. The issue is whether the simulation's rates are in reasonable agreement with the scenarios the simulation depicts. Alternatively, the issue is whether the simulation produces rates indicative of operational-level scenarios specifically not depicted or assumed.

The rate patterns of greatest interest at this final analytic level are the several basic compositions of major operational phenomena (described in Chapter 5) that form the different fundamental scenarios themselves and the rates associated with them.[1] The operational-level rates should be composed of the kinds of operational-level phenomena known from the empirical evidence to be associated with such rates.

THE BASIC COMPARISONS: THE REALISTIC MILITARY PHENOMENA IMPLIED IN THE SIMULATION'S RATES

The simulation's operational-level battle casualty rate results are best understood when displayed in terms of the major scenarios and associated rates found in the empirical evidence. Table 6-1 sets the simulation's results into this larger empirical framework.

General Overview

The planning scenario the simulation attempts to depict is a continuous front. However, the rates the simulation produces are compatible only with disrupted front scenarios. In particular, the scenario represented is apparently a third-order disrupted front. The peak 10-day rates for NATO army-size forces (Armies "A" and "B" and the U.S. Force) most closely resemble those seen for the Germans during the

[1]The more detailed rate patterns reviewed in Chapter 4 underlie, or are constitutive elements of, these larger scenario-driven patterns.

TABLE 6-1

OPERATIONAL-LEVEL CASUALTY RATES AND SCENARIOS

Campaign	Force size measured (no. of "armies")[a]	Time period measured (days)	TBC peak rate (per 1000 per day)	Scenario (front type)
Yassy-Kishinev	2(+)	10	~48	DF-4
Belorussia				
[2nd 10 days]	1(+)	10	~70	DF-4
[full operation]	[2]	[23]	[~35]	[DF-4]
Belorussia				
[1st 10 days]	2	10	~36	DF-3
Vistula-Oder				
[peak 10 days]	1(+)	10	~32	DF-3
[full operation]		[23]	[~15]	[DF-3]
Omnibus 89				All assume CF (Def)
Total NATO				
[peak 10 days]	2	10	30	
[full operation]	[2(+)]	[60]	[24]	
Army "A"				
[peak 10 days]	1	10	33	
Army "B"				
[peak 10 days]	1	10	29	
U.S. Force				
[peak 10 days]	1	10	33	
[full operation]	[1]	[60]	[22]	
Lvov-Sandomierz [1st 10 days, with Kovel Pocket]	1	10	19	DF-2
Lvov-Sandomierz			All ≤ 9-14	
[2nd 10 days]	1	10		DF-1
Kharkov	1	10		DF-1
Donbas	1	10		DF-1
Ardennes ("Bulge")				
[1st 10 days]	1	10		CF (Def)
Central Europe				
[November '44]	1	10		CF (Ofs)
Normandy Period				
[June - August '44]	1	10		CF (Ofs)

Note. Table 6-1 is derived from Tables 5-1 and 5-2. DF: disrupted front; CF: continuous front.

[a]This measure is based on our standard procedure of terming an "army" the collection of divisions that usually numbers about 10 to 15, but may be as low as 8 or as high as 22. We have attempted to use a consistent (and resilient) force size definition, rather than merely describe official Order of Battle (O/B) data peculiar to each event. Even so, most events cited do use the O/B measure. The Yassy-Kishinev, Belorussia, and Vistula-Oder campaigns were such large-scale and rapidly developing (changing) operations that the more standardized measure of force size was the more practicable one.

worst 10-day period of the Vistula-Oder campaign or the initial 10 days of the Belorussia campaign.

However, the *form* of the operational phenomena represented by the simulation is altogether inappropriate to such rates. The simulation attempts to depict a NATO line that is hard-pressed and withdraws in certain areas. The line does not ultimately break. Soviet/Warsaw Pact armies – which is to say, in our parlance, corps-size forces – do not penetrate behind NATO lines and exploit the rear areas. NATO corps do not disappear in catastrophic encirclements.

Realistically, a third-order disrupted front is associated with catastrophic and near-catastrophic encirclements of multiple corps within a force of one or two armies. The Belorussia casualty rate reached 35/1000/day over the operation's full 23 days only because three corps were destroyed in the first 10 days (at a rate of some 36/1000/day for a 36-division force) and another four corps were destroyed the second 10 days (at a rate of some 70/1000/day for the remaining 23-division force). The Vistula-Oder campaign rate reached about 32/1000/day when several divisions in penetration sectors were destroyed outright and another 14 divisions were then quickly cut off, seven of which simply disappeared. *Such is the form of the rates characteristic of high-level disrupted fronts.*

Rates on the order of those sustained during the Belorussia or Vistula-Oder campaigns indicate an operational-level force effectively destroyed militarily. Yet the simulation produces just such rates – for the peak 10-day periods – while showing all NATO corps, and the full force, remaining militarily proficient.

Worse, the simulation produces rates across the entire NATO front over the full 60 days that outstrip even the highest rates seen in any of the Eastern Front campaigns we reviewed. The full NATO force rate is 24/1000/day for a force that eventually reaches the size of two large armies (45 divisions). The overall Belorussia campaign's rate of 35/1000/day held for only some 36 divisions over a period of 23 days. Because the simulated force reaches a size some 25 percent larger and its rate period is nearly three times longer than was the case in the rapid Belorussia operation, the simulation's rate effectively exceeds even the rate suffered by the losers in that stunning campaign.

The U.S. Force

The U.S. divisional force's rates must be displayed within the larger NATO context. Table 6-2 shows the U.S. force's high 10-day rate and its overall 60-day rate are both indicative of disrupted fronts. The U.S. rates may be examined more closely and again assessed in terms of military phenomena the empirical evidence indicates would in fact be associated with them.

TABLE 6-2

SIMULATED U.S. FORCE 10-DAY TBC RATES

Time period	Count of division days	Divisional averages. TBC rate (per 1000/day)
Days 1 through 10	60	13.9
Days 11 through 20	88	12.4
Days 21 through 30	110	26.8
Days 31 through 40	120	29.1
Days 41 through 50	138	22.8
Days 51 through 60	194	22.4

A casualty rate of 13.9/1000/day for a corps-size force of six divisions (Days 1 through 10) is not especially remarkable. Such rates may occur in either continuous or disrupted front scenarios. The U.S force rate remains at about the same level (12.4/1000/day) for Days 11 through 20, but now the force is army size with about nine divisions. Such a rate could also be seen in either a continuous front defensive scenario or a first-order disrupted front, especially for a force that is barely army size.

That either the 13.9 or 12.4/1000/day rate for the first two 10-day blocks could be credible requires the further remark that they are credible when such forces are under serious pressure by the enemy; such is not the case so early in the time line for Omnibus 89. Instead, the U.S. sector is a fix sector.

Whatever the case with regard to the first two 10-day periods, things change as of Day 21. Over the next four 10-day periods, the size of the U.S. force grows from 11 to over 19 divisions. Rates range from about 22/1000/day to 29/1000/day. Such rates for such forces and times suggest scenarios that, in realistic operational terms,

can only be disrupted fronts. The following kinds of operational phenomena would be seen in these scenarios across the U.S. force: during four successive 10-day periods, the occurrence of one or two major breakthroughs in the U.S. sector *per period*; during the third and fourth periods, multiple corps-size forces catastrophically and near-catastrophically encircled *per period*; during the fifth and last periods, one such catastrophic encirclement of a corps-size force *per period*.

Obviously, no such events occur in the simulation's scenario. The simulation is premised on a continuous front setting. Figure 6-1, therefore, contrasts the Second World War's five highest continuous front 10-day rates (seen in the West) to the six 10-day rates for the U.S. force in the simulation.

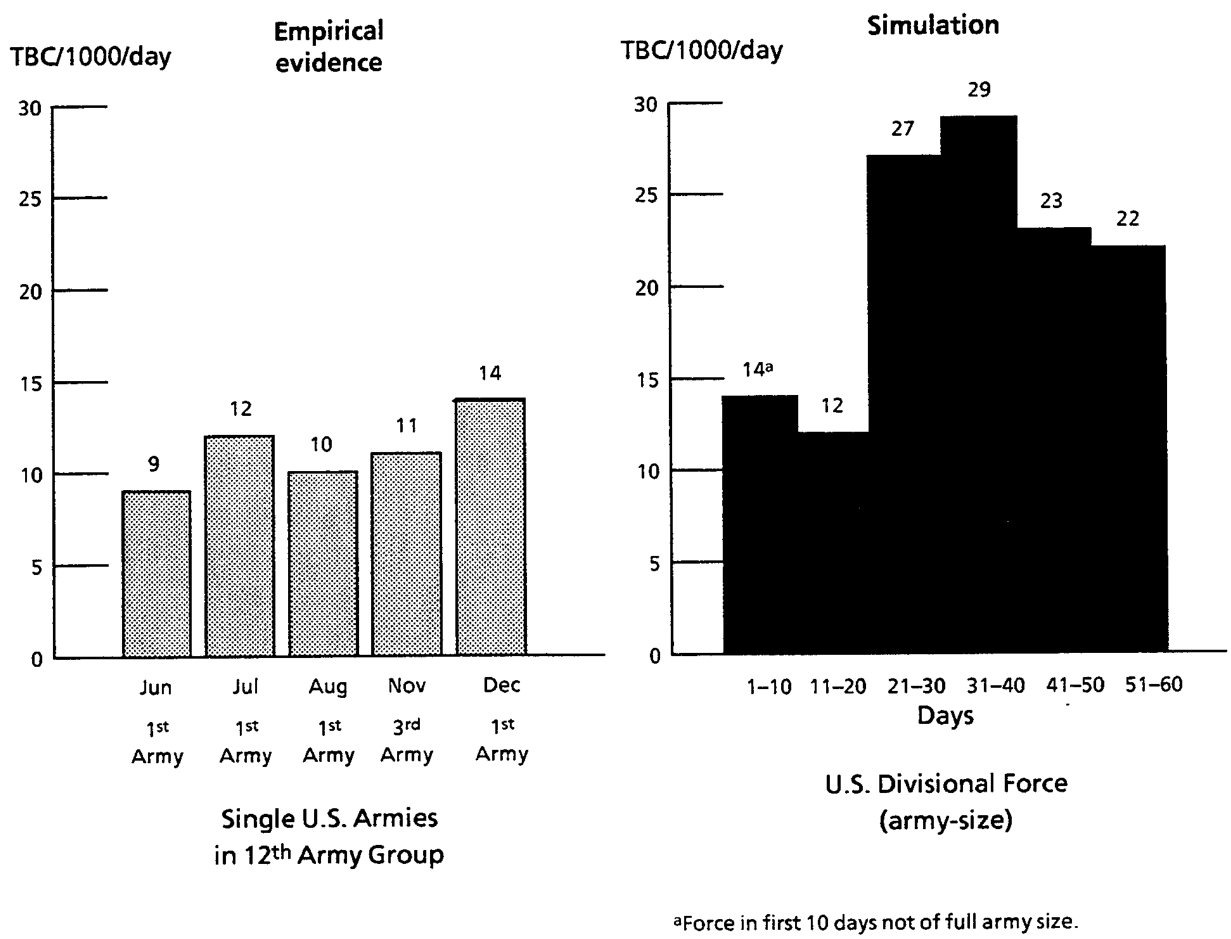

FIG. 6-1. COMPARISON OF EMPIRICAL EVIDENCE AND SIMULATION RESULTS
[Army-level 10-day peak rates (TBC/1000/day)]

Again, the simulation's output does not reflect the kinds of operational phenomena characteristic of real-world continuous fronts. Where rates along actual continuous fronts measured by a 10-day moving average show high rates only in distinct pulses in separate time periods, the simulation shows high rates continuously over a full 60 days. This lack of rate pulses separated by intervals of lower rates stands in addition to the fact, already indicated in Table 6-1, that rates in these kinds of scenarios in actual combat simply do not reach the levels seen in the simulation's last four 10-day periods.

SIMULATION RATES: EXCESS FROM MODERATION

What has become clear in our analysis of simulated combat rates is what might be termed, at least in the case of this simulation, an excessive moderation of rates. The simulation uniformly produces what, by empirical standards, are moderate to high-moderate rates (e.g., rates in the range of 15-to-45/1000/day), and persists in their production to the point of excess when the sum of rates is totaled for operational-level forces and time periods.

The simulation's excessive moderation fails to produce rates nearly as high as should be expected in certain operational contexts (e.g., breakthrough sectors and successful exploitations) or rates nearly as low as should be expected in other contexts (e.g., fix sectors).

Chapter 4 details the persistent uniformity found in the quantitative characteristics of this simulation's rates. We finally turn to a display of that uniformity in terms of kinds of sectors within the different major scenario types. What are essentially moderate rates at the level of single divisions for short periods of time become excessive rates at the level of corps and armies of divisions[2] for operational time periods.

The empirical evidence is clear, once again, on the rate patterns to expect: for all scenario types during the breakthrough period, expect extremely heavy rates in focused sectors and low median rates across the whole force; for both continuous fronts and lower-order (first- and even second-level) disrupted fronts, expect a continued low median rate and a moderating over time of the imbalance of high and low rates across sectors of the front; for higher-order (third and fourth level)

[2]Of course, a moderate rate for a single division may also become excessive for that single division if carried on for too long a time period.

disrupted fronts, a significantly higher median rate and the continuation of the imbalance of high and low rates across the front, as significant numbers of units are catastrophically encircled.[3]

Figure 6-2 displays a 1-day view of corps rates across empirical and simulated front lines for fronts held by multiple armies. The empirical data show the U.S. 12th Army Group on the second day (17 December 1944) of the German offensive. The rates range from .2-to-2.1/1000/day on the flanks of the attack sector, to 9.5/1000/day for a corps caught in the midst of its own offensive, to 8.8-to-59.4/1000/day in the main penetration sector. The high corps rate of over 59 was, 2 days later, dwarfed by that same corps experiencing a rate of 111 – marking the surrender of two-thirds of a single division in that sector.

The simulation data overlaid on the empirical data show the laterally-arrayed simulated corps 1-day rates for the highest- and lowest-rate days, respectively. If one assumes for the sake of the analysis that a breakthrough is under way on one or both of these days, the interest would be on whether the differentiation in rates across the front betokens the breakthrough. While the simulated corps do show some rate differentiation on both the lower- and higher-rate days, in each case the degree of rate difference along the front is inappropriately low for a breakthrough period. That relative difference is even less on the high-rate day – when the overall front rate might more so indicate a breakthrough is under way – than on the low-rate day, principally because all the corps rates on the high day are relatively high.

The empirical evidence indicates that for any major scenario type – continuous or disrupted front – sector rates should be dramatically different during breakthroughs. Yet in all cases in the simulation, the rates across the front for single days reflect neither the marked highs to be expected in the breakthrough sector(s) nor the lows to be expected across the rest of the front in less pressed flank (fix) sectors. What rate differentiation does exist across the simulated front is relatively slight – moderate – and gradually lessens as the general set of rates rise everywhere during the overall high-rate periods.

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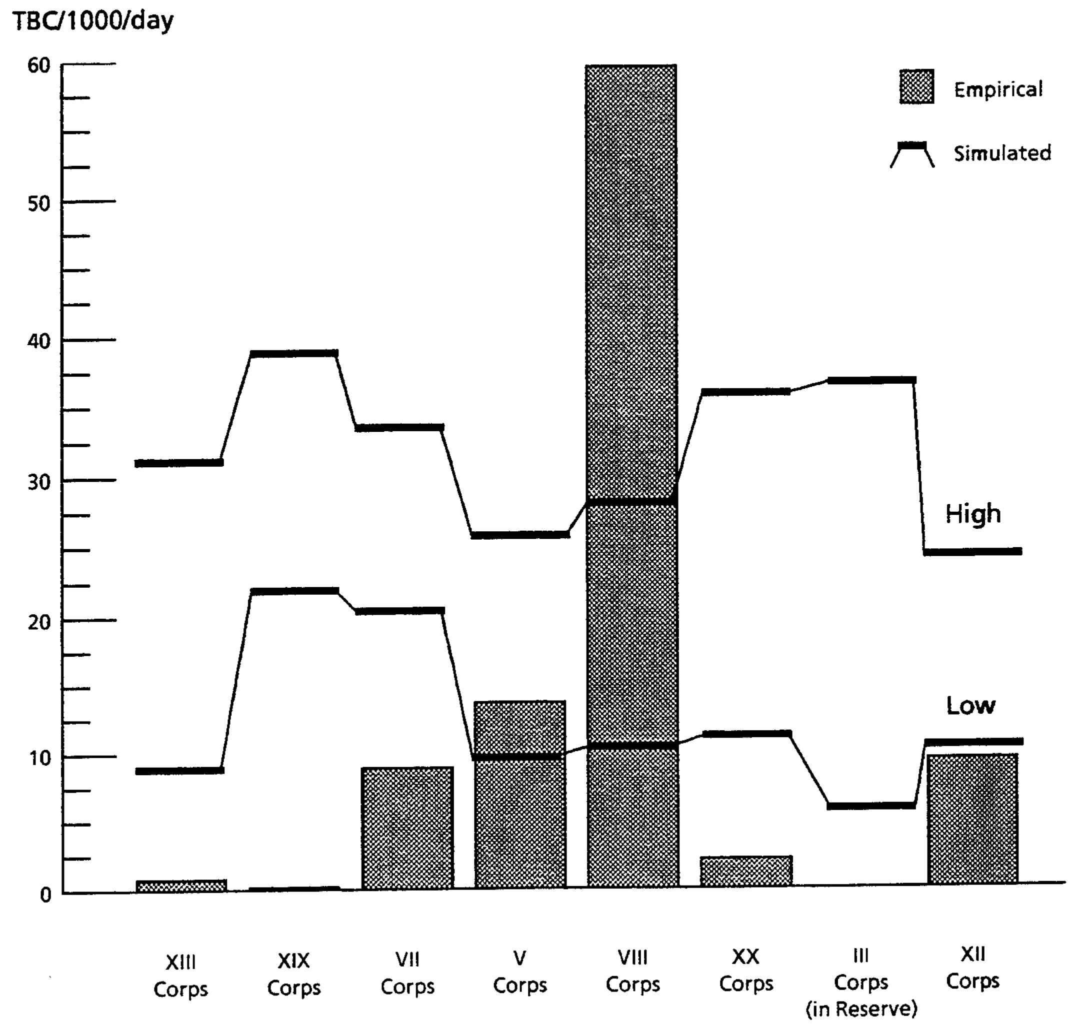
[3]The issue of force ratios that are needed to achieve breakthroughs and successful subsequent encirclements at the operational level, and the related question of how combat power is measured, are beyond the scope of this study. The key for this study is that the empirical evidence is clear that casualty rates along a front will dramatically reflect focused effort when those ratios of relative combat power – however comprised and measured – are brought to bear.



Note: Empirical data for corps in 12th U.S. Army Group, 17 December 1944. Simulated data for corps during "high" and "low" TBC rate periods for full NATO force.

FIG. 6-2. COMPARISON OF CORPS 1-DAY CASUALTY RATES

The issue then becomes one of whether the simulation depicts sector rates reasonably well when seen from a longer-term perspective. The longer-term view would link a breakthrough with the subsequent operational period: an exploitation without significant encirclement (for continuous and first-level disrupted fronts), or with significant encirclement (for a higher-order disrupted front).

We know from the empirical evidence that the differentiation of rates across the front in continuous front and first-level disrupted front settings will continue to be

dramatic though at a lower level of rates. This lower rate reflects the averaging of the initial high rate in the breakthrough sector(s) with a distinctly lower rate in that same area during the subsequent exploitation period.

In the case of the higher-level disrupted fronts (especially the third and fourth levels), the overall front will continue to display dramatic rate differentiation across the front. This differentiation will continue to show high rates in distinct locales along the front – now, the area(s) of encirclement[4] – in contrast to the rest of the line or force.

Figure 6-3 displays 10-day periods from the empirical and simulation data. The empirical data show the 12th Army Group's front during the Ardennes campaign's first 10 days. The rate for the U.S. VIII Corps remains dramatically higher than those for other corps, but at a reduced level since the exploitation period saw generally lower rates. Again, such is the expected pattern for either a continuous front (as here) or first-level disrupted front.

The simulation corps rates again fail to show appropriate differentiation. If the simulation is supposed – as the planning scenario provides – to depict a continuous front (or even first-level disrupted front), the sector rate differences ought to be significant, with the higher rates in a more focused portion of the front than would be the case in one of the higher-order disrupted fronts. If the simulation portrays any of the latter scenarios – which, as we have seen, the *magnitudes* of its overall army-level rates would certainly indicate – then the sector(s) showing the dramatically higher rates would still be distinctive along the front although they would occupy a broader portion of the front in accordance with the level of encirclement achieved.

The simulation shows low differentiation of rates across the corps sectors in both the high- and low-rate periods. In neither instance does the degree of differentiation depict what must be expected of any of the major operational scenario types. Even in the case of a higher-level disrupted front, where the sector area(s) of

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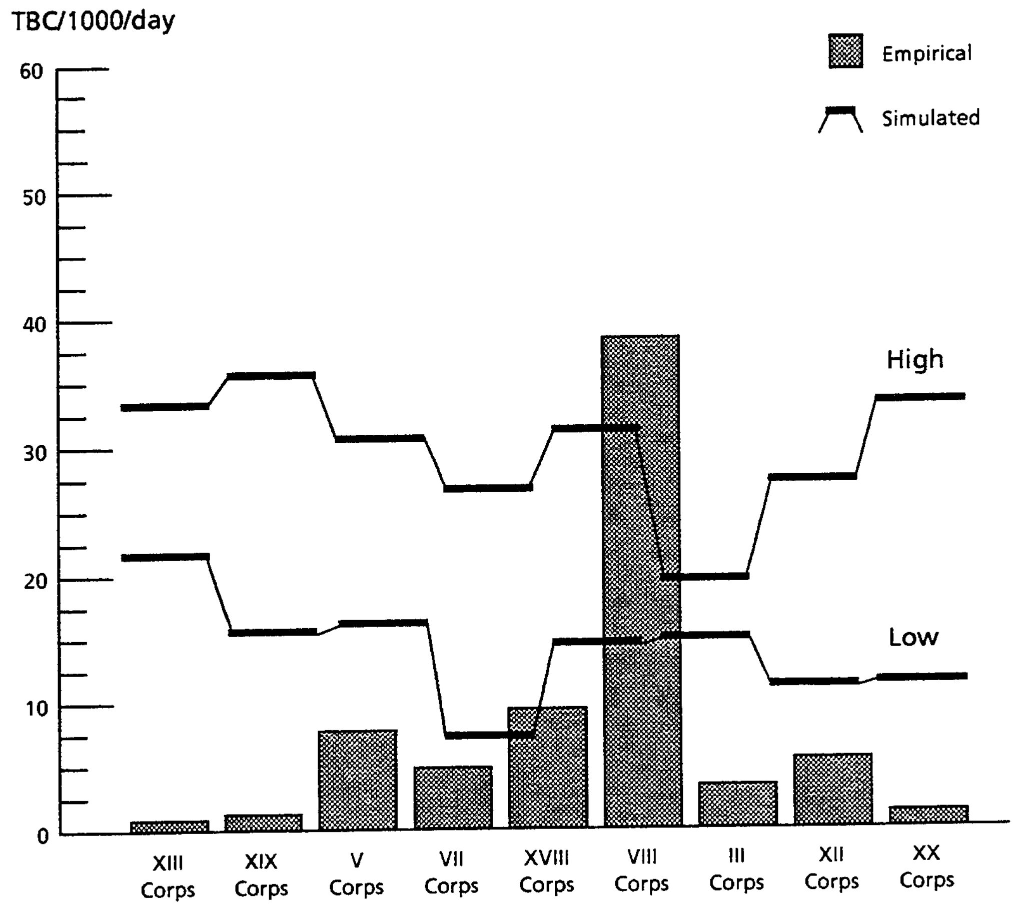
[4]The units encircled during the three higher-order disrupted fronts will probably include a combination of some that were initially in the breakthrough sector(s) and some others which during the breakthrough had been along the broader (fixed) front, probably adjacent to the breakthrough, or in rear areas. Significantly, encircled units will not be limited to those merely in the immediate vicinity of a breakthrough. Depending on the severity of the disrupted front setting, an encirclement may include units further away (along the front or in rear areas) from a breakthrough. Higher-order disruptions will cover relatively wider swaths in their encirclements.



Note: Empirical data for corps in 12th U.S. Army Group, 16 – 25 December 1944 (locations on 25 December). Simulated data for corps during "high" and "low" TBC rate periods for full NATO force.

FIG. 6-3. COMPARISON OF CORPS 10-DAY CASUALTY RATES

high rates was much broader than that of a continuous front situation, the sector(s) would not span the entire theater.

But the simulation's 10-day sector rates are even more troublesome. First, the low-rate period rates are higher on the 10-day scale than on the 1-day scale.[5] (This recalls the analysis in Chapter 4 which shows the simulation tendency for all rates to seek a certain mid-range level.) More important, however, now *all* simulation corps rates but one, considering both the low- and high-rate periods, are *significantly*

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[5]Where the 1-day low-period rates generally occur in the area of 10/1000/day (with one rate at half that level and two rates over 20/1000/day), the 10-day low-period rates move upward to between 12-and-17/1000/day (with one at half that and one over 20/1000/day).

higher than *all* the empirical corps rates but one: the corps in the penetration sector. And that latter actual corps rate is *higher* than *any* of the simulation corps rates, bar none.

Once more, the simulation's tendency toward uniformity is shown. The simulation's tendency to make what on certain (single-division, short-time) scales is a moderate uniformity into an overall excess is also shown: the entire simulated theater front during the high-rate period (but for a single corps) shows rates that would denote a penetration sector rate for a single actual corps. That is, the simulation in essence represents the entire European front during the 10-day high-rate period as if it were a single corps penetration sector. Worse, when the uniformity of the simulation's rates over the last four 10-day periods is recalled, this corps-level penetration sector phenomenon effectively blankets the entire NATO front from the North Sea to the Alps for the full period. Whether for 10 or 40 days, that is a military *non sequitur.*

CONCLUSION

The simulation's results present an irony. From the perspective of an operational-level scenario (an army-size force or larger for a period of 10 days or longer), the overall rates produced clearly imply a high-order disrupted front. Yet from the point of view of the rates actually displayed in scenario sectors across the front and over time, neither such a disrupted front nor in fact any of the known scenario front types is portrayed.

The simulation fails to produce rate patterns reasonably in agreement with those known from the empirical evidence to be associated with the patterns of operations. Turning to other simulation output – such as seen in Figure 3-1 for runs that supported official rate projections – reveals the same failing. Usually, a single 10-day peak rate pulse is followed by gradually dwindling rates (with no recurring pulses) over the longer time line. Occasionally, as with Omnibus 89, that pulse occurs later and endures far longer. For scenarios assuming major pressure against the U.S. sector, the one pulse – whether early and brief or later and longer – dominates the time line.[6] Rates across the front – whether during a pulse or a

[6]In some recent instances, the rate appears to contain no pulse. The problem is that these relatively flat rate curves are in effect only extended pulses – similar, though at a lower level, to the long pulse in Omnibus 89. The rates shown in these long, flat curves dwell at magnitudes that realistically would represent peak rates and ought to occur in shorter, distinct pulses.

low-rate period – are inadequately distinguished by sector. This lack of adequate differentiation by sector is especially inappropriate for forces on the defensive.[7]

The result of such incongruence with realistic patterns of operations and their rate characteristics is a set of rate projections which are difficult to relate reasonably to any scenario type but which, in any case, clearly do not realistically reflect planning scenarios.

[7] The failure to heed rates in terms of patterns of operations is also found later in the Army casualty estimation process. The model used to identify pre-calculated casualties by probable branch, rank, and occupational specialty – the Casualty Stratification Model (CSM) II – assumes a uniform distribution of personnel laterally across the front. No allowance is made for the fact that rates occur in pulses in a *lateral* sense – in combat sectors (such as breakthrough versus fix sectors) – just as they do in time. Further consideration of this "stratification" process was outside the scope of this study of rates.

CHAPTER 7

GENERAL OBSERVATIONS ON CASUALTY RATE PROJECTIONS BY "ASSIGNMENT" METHODOLOGIES

GENERAL

Our review of the methodologies supporting U.S. and Allied casualty rates indicates two fundamentally different approaches to the problem of projecting possible casualty rates. We will term these approaches "assignment" and "calculation."

Assignment refers to the practice of planners taking rates already identified (through other means such as studies or simulations) for certain force types and postures or conditions, and assigning those rates to a set of forces and conditions they envision for a planning scenario. Calculation refers to the use of some means – usually a mathematical simulation – by which a particular planning scenario is "played," given that particular set of forces and scenario set into the structure and rules of the calculator, and its results then used for planning.

Most current casualty rate methodologies are versions of assignment, though analysts appear inclined to move to simulation as the principal supporting method. That inclination is understandable, since assignment necessarily takes predetermined values and attempts to fit them to projected forces and scenarios – an approach not as appealing as the prospect of producing a casualty rate out of the particulars of the planning scenario. Simulation, of course, appears to offer precisely the latter prospect.

The question for now, however, is not so much which approach is more appealing as which approach is concretely more reliable.

The art of combat simulation remains young, especially for higher-level combat interactions. Simulations have many difficulties. The most common concern about them appears to be with the credibility of their representation of the pace and intensity of combat interactions. In relation to casualty projections, the weakness of simulations is perhaps as much or more their seeming inability to capture the nature

of the operational patterns and the underlying distributions of casualty rates. The preceding chapters compare in some detail the results of one major simulation to the patterns of casualty rates seen empirically.[1] Simulations have great difficulty replicating the pulsing and variability that characterize actual rates. As a result, simulations have difficulty representing the nonuniform ranges and distributions of rates associated with differing force sizes, time periods, and general scenarios.

Until such time as calculators (simulations) more realistically represent the patterns of personnel casualty phenomena, assignment may in fact offer the more reliable approach, even if it is inherently the less attractive one. However, assignment methods currently in use are as subject to the kinds of weaknesses just described as are simulation methods. This chapter outlines some of those major shortcomings.

We at least touch on major features of the following casualty rate methodologies: the U.S. Army's FM 101-10-1, the U.S. Marine Corps's current and newly proposed methodologies, the U.S. Medical Planning Module (MPM), the current planning tool made available by SHAPE, and the approaches used by the FRG and the UK.[2] The complexity and idiosyncrasies of each methodology mean that its detailed or individual consideration is beyond the scope of this report. Instead, we address the several approaches in terms of issues common among them.

GENERAL OBSTACLES TO ASSIGNING CASUALTY RATES

The principal difficulty with the attempt to assign casualty rates to planning scenarios is, of course, that the rate values used may not fit the particulars of the scenario. Assignment methods must be especially careful when defining rates and procedures to use in characterizing different forces, times, and scenarios. Some assignment approaches heighten this inherent difficulty by providing planners only

[1]Our discussions in 1987 and 1988 with analysts of the FRG revealed that the Germans were experiencing precisely these kinds of problems in their then-new corps simulation – except that concerns about that simulation's pace and intensity were, if anything, even greater than those raised by the results shown in the preceding chapters.

[2]The British methodology is unique. A study in 1979-80 *calculated* a total number of casualties that would be sustained during the planning period. No regard was paid to the time distribution of those casualties. No attempt was made to provide planners a method by which casualty estimates might be changed with changed planning time period or scenarios – a constraint referenced in several subsequent British commentaries on the question of rates. We include this approach under assignments since, in effect, it becomes such a method once any change in planning time, scenario, force size, or composition occurs.

limited choices of rates or of procedures for their application. Others heighten it by in fact giving planners so much leeway as to provide them effectively no guidance at all.

FOUR AREAS OF CONCERN

Our discussion follows the general framework of themes laid out in both the first report and this report's previous chapters. We first turn to questions concerning rate values themselves and then offer observations on the interdependent dimensions of force size (echelon), time, and scenario. As was the case with our separation of the temporal and lateral dimensions in our analysis of the underlying quantitative characteristics of rates in Chapter 4, our discussion here will inevitably overlap among the four areas of concern.

Characterization of Rates

Overview

A first concern about assignment methods focuses on the character and sources of their rates. In all cases the rates used are point values. The sources of these values range from historical data to simulation and analytic data, or some mix.

Comments

Character of Point Values. Planners must be aware of the character of the point values used in assignment methods. Since planners normally focus at the tactical level, the point values are usually stated in reference to a size and type of unit and its posture for a short time period (one or a few days) – for example, a division or an armored brigade on the defensive for a day. Other methodologies attempt to define point values not for unit types and postures but for levels of combat intensity.

These point values appear to be averages (probably means) of the specific experience (posture or intensity) they attempt to express. For example, a rate for the first day of a meeting engagement or amphibious assault is probably the mean value of many such first days; likewise, the value of a certain level of combat intensity. As such, the values subsume many such experiences. It is critical to note that the values may not subsume the actual distribution of rates characteristic of those experiences (whether postures or intensities). The experiences may represent, for example, only a selected subset of peak casualty rates for a given posture.

Point values will tend to be pulled high, in three senses. First, they are defined from the outset in terms of significant military activity: defense, attack, withdrawal, moderate intensity, etc. As such, the particular experiences they attempt to capture are the "hot spots" of combat that garner so much attention. They ignore the empirical evidence that, no matter how intense the overall action may be, there are significant amounts of time when the chosen descriptor does not really pertain.

Second, whether keyed on postures or levels of intensity, they appear to focus on significant examples of that experience. For example, when defining amphibious assaults the Omaha Beach experiences (where action was intense) will be used and the Utah Beach experiences (where action was light) will be ignored or discounted.

Finally, even when the full range of possible experiences of the type described (posture or intensity) is counted, we know from the empirical evidence that combat rates are skewed toward the high end. Therefore, even a mean that accurately represents the full distribution of experiences of a particular type will be higher than, say, the median would be. Of course, the worst cases of point values being pulled high are those that show a mean value for only the most intense cases of a significant military activity.

Whatever the particular character of a point value, its use may easily lead to problems. A point value will, in fact, lack meaning – or be misleading – when used for anything other than the value it supposedly represents (one armored brigade, on defense, 1 day; or one intense day of combat). The problem is not so much the point value's use for any given day's rate, since we know from the empirical evidence that a given day's rate may range quite broadly. In fact, for a single day, the use of even worst-case point values may well understate a possible rate experience.

Problems using point values grow as the value in question is attributed to more and more day-experiences (again, either as unit postures or as intensity levels) in any given scenario. A planner who is unaware of the dramatic variability of actual casualty rates, even in "intense" periods and sectors, will easily tend to apply a point value descriptor to a unit or force for periods far longer than the *rate* used in the descriptor would be warranted.

Before turning to the sources of point value rates, we should also observe that the solution to the problem of point values and their misuse is not as simple as some have suggested. Some have advanced the idea that the weakness of point values may

be adequately overcome if for any given unit-day and posture, or intensity level, a set of three values (high, medium, and low) is made available to the planner.[3]

While in one sense this proposed remedy may be an improvement, it fails to address the underlying problem: the credibility of the *distribution of rates* is not improved whether the planner has one or three single point values to choose from. For example, if the planner is free to use the "high" or "low" version of the set of point values at will, how is there an improvement in the representation? Merely providing a range of point values does not address the fundamental problem of credibly representing the distribution of values inherent in a combat scenario.[4]

Sources of Point Values. Finally, we turn briefly to the question of the sources of the rates used in assignment methodologies. The sources range from historical data to data taken from simulations or studies to a mix of those data. The usefulness or reliability of the rates rests heavily in their origins, an issue few seem interested or willing to raise. We offer only a few glances into this realm of origins.

The U.S. Army's Field Manual (FM) 101-10-1 is widely acknowledged as a resource both in the U.S. and abroad. Yet, few seem aware that the structure of operational postures described in one of its most frequently used tables of rates (Table 4-18 in the latest version) rests in the operational practices of World War I. The table's structure of operational categories precisely repeats that of a predecessor table developed to describe World War I experience. An "attack of a position" or "attack of a zone" had a distinctive meaning in that war's context of relatively immobile, massed troops facing each other in opposing trench systems. We would question whether such categories can be properly applied to the structures of forces and the ranging, mobile operations that characterize more modern conventional operations.[5]

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[3]Such an approach is taken in the methodology and set of rates currently under consideration for use by the U.S. Marine Corps. The proposed rates are generated by a simulation. For each intensity level defined, the planner is presented three possible rates (high, medium, and low).

[4]The table of rates included in the proposed methodology for the Marine Corps describes ranges between the "high" and "low" versions of each intensity level which are, in fact, so narrow – given that the force size in question is generally a single division, brigade, or battalion – as to call into question why the distinctions are made.

[5]Certainly, "positions" and "zones" are still attacked. But their characters, and the characters of operations and forces, are generally so different since at least 1940 as to beg the question of the usefulness of the categories. At the very least, such categories might be set aside to describe positional operations involving relatively fixed, fortified lines and zones – Korea became such an affair after its first several months, and it may be that we will find the Iran-Iraq war shared certain of these features – and a wholly different approach be adopted to categorize more mobile operations.

Further, the rates found in today's version of the table again reflect precisely the rate proportions originally defined in World War I experience.[6] To be sure, the rates given in more recent versions of the manual (formerly FM 101-10) have been considerably reduced from those for that war. But the manner of the reduction raises questions.

World War I rate values were still in use in the October 1944 version of the field manual. Then, in the December 1944 version, *all* the World War I rates were reduced by one-quarter.[7] Those 1944 rates remained in use through the end of World War II and through at least the September 1946 version of the manual. The August 1949 issue of the manual finally changed the 1944 rates: again *all* the rates were reduced by an equal amount, this time by almost exactly one-half. Thus, today's rates stand at about 37 percent of the World War I rates. But the fact the rates describe a World War I operational structure, and reflect merely a lower version of exactly the same general rate proportions as the World War I data, raises serious doubts.

Turning from the field manual to the MPM process, the rates used for Army forces are due to a mixture of simulation results and "military judgment." The highest level of intensity is denoted by a rate that was in fact the peak 10-day rate in one run of the Army Staff's mathematical simulation for Europe in the early-1980s. The rates for lower levels of intensity were apparently then defined by staff officers simply using that peak 10-day rate as a beginning reference point.

The current U.S. Marine Corps set of rates owes much of its origin to a late-1970s study.[8] The study sought to define rates by comparing the relative firepower of certain World War II divisions to the firepower of certain then-contemporary divisions – in terms of rates of fire and tonnage of salvo. Despite the fact that surveys of actual operational casualty rates have shown the lack of a positive

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[6]The era of the original rates and proportions is perhaps best illustrated by the fact that the original table provided rates for both "men" (these rate proportions remain) and for "animals." The category for animals was finally dropped in the December 1944 manual.

[7]The October 1944 manual included both the official table of rates, showing the World War I rates, and a student exercise table showing the rates subsequently officially adopted in the December 1944 manual.

[8]*Medical and Dental Support System (1984-1993)*, Volume II, Potomac General Research Group, 3 October 1977. Prepared for Marine Corps Development Center, Marine Corps Development and Education Command, Quantico, VA. Contract M00027-76--A-0060. (SECRET)

relationship between ground casualty rates and increases in such gross measures of firepower as rates of fire or throw-weight per shot, that study then took certain World War II casualty rates and simply multiplied them by the increased firepower index so assessed.[9] It found, however, that this procedure resulted in casualty rates that were unacceptable. Therefore, it reversed course and defined a maximum sustainable rate of casualties for certain portions of a division – lower than the elaborate firepower-based procedure had indicated – and declared that rate to represent the highest-intensity environment. The ultimate definition of a maximum rate, then, rested mostly on a process of deducing the rate. The deduction keyed on an asserted maximum militarily sustainable rate for a certain subset of the Marine division, and then used proportions of casualties among division personnel already defined elsewhere (especially the Army's FM 101-10-1). Lower-level rates were differently established. One method took the deduced highest-intensity rate and multiplied it by a ratio that represented the lower-level intensity's firepower index compared to the highest-intensity firepower index. Another method simply sought rate values (from other established sources) that would provide "suitably graduated" (i.e., lower) rates believed appropriate to the lower level of combat intensity.

The current British casualty estimate also dates to a late-1970s study.[10] The study began with an overall time line for operations already established by a combination of simulation results and policy decisions, and with an authorized definition of a maximum level of militarily sustainable casualties (which was made more precise and somewhat reworked in the study). Within those parameters, the study then focused its attention on battalion-size units ("battle groups"). A number of operational postures for such units were selected, and in each of them a battle group was placed in a worst-case firepower exchange scenario. The rate results for these low-level tactical vignettes were then applied across the entire British corps – to be sure, using military judgment as to frequency and location of occurrence.

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[9]Refer to our first report, especially Chapters 3, 4, and 10. Professor James Schneider of the U.S. Army's School for Advanced Military Studies at Ft. Leavenworth has observed that the general argument has been advanced since at least Quincy Wright's famous work, *A Study of War*, was published in 1942. It has been extensively documented and long argued by Trevor N. Dupuy, the noted military historian and analyst.

[10]*Battle Attrition Study*, Director of Military Operations, Ministry of Defence D/DMO/43/16/MO (Studies), 31 July 1980. (UK SECRET)

This is, of course, only a partial list of rates currently used in official assignment methodologies. We review it not to pinpoint these particular rates – other candidates would serve as well[11] – but simply to point up the fact that the rates used in current assignment methodologies are often questionable when the issue is whether they represent reasonably well the character and distributions of real-world casualty rates across varying forces, times, and scenarios. Aside from the matter of their expression usually as point values, the content of rates should raise great concern as to what it is the planner is actually applying when he attempts to make sense of a scenario.

Characterization of Force Size

Overview

Three principal difficulties arise with regard to force size characterizations. First, force analysis is usually focused at the tactical level, even when a theater force is at issue. Second, the echelon used to analyze or produce casualty rates is often lower than the echelon to which the rates are then assigned. Finally, in several

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[11]The list is long, as three further examples will help illustrate.

FM 101-10-1 contains tables of rates in the medical chapter (Chapter 5) which, while of much more recent origin than Table 4-18 cited above, are equally questionable as concerns appropriateness of force sizes and time periods of application. SHAPE's suggested rates are contrary to empirical evidence both in their stated relative magnitudes of offensive versus defensive rates and in the casualty rate values provided in terms of the force sizes and time periods originally contemplated.

A good example of a potential source of major error in arriving at casualty rates is the set of definitions of combat intensity levels in certain U.S. publications. For example, the Joint Operations Planning System (JOPS) III Medical Planning Module (MPM) Users Manual attempts to define levels of combat intensity by suggesting proportions of fire support and maneuver echelons engaged during the action.

The proportions suggested are agreeably logical – the levels of combat go from low to high by engaging steadily more of the force until 100 percent are engaged. However, the proportions simply do not bear out in the empirical evidence for ground combat when the issue is casualty rates.

For example, planners are instructed that the differences between "light combat," "moderate combat," "heavy combat," and "intense combat" are based on the following levels of fire support and maneuver echelon engagement: Fire Support ["less than 50%," "over 50%," "all," and "all"] and Maneuver Echelon engagement ["less than 30%," "30 to 60%," "more than 60%," and "all"]. Of course, since no one can easily imagine "all" fire support and maneuver echelons engaged *at all times* during an action, the "intense combat" category is qualified by stating "maximum available" or "all.... potentially engaged."

Our research into combat down to regimental and even battalion levels has shown that even quite intensively engaged divisions will often show only some 30 to 50 percent of their maneuver battalions heavily engaged on a given day. We offer this figure only as an example of the difficulty of such definitional approaches – not as an alternative definition.

cases, the issue of force size and its association with casualty rates is effectively ignored.

The three difficulties find a common end. Rates of lower-echelon engagements are aggregated to larger force settings, using some usually overstated view of proportions of the larger force that would be thus engaged. The result is that while the rate cited may be appropriate to a lower-echelon force, its assignment to the higher echelon force overstates the rates that would realistically apply at that higher echelon *even when* rates as high *or higher* than the rates cited are seen at the lower echelons.

Comments

An example of the first difficulty – taking a tactical perspective even in an operational-level environment – is raised by use of the Army's FM 101-10-1. That field manual strongly, if implicitly, encourages planners to focus on the tactical level. It basically provides planners with two sets of rates: those for periods of 5 days or fewer and those for periods greater than five days.[12] It specifies that division-size units should be considered under the former heading, while corps or larger forces may be calculated under either the short-term or longer-term approach. The two sets of rates differ dramatically. The former (short-term) set shows some appreciable rate differences according to posture and whether it is the first or a succeeding day of combat. The latter (long-term) set shows extremely low rates – based on World War II average rates for a theater force of divisions over nearly a year's combat.

Planners using the field manual – such as those on the U.S. Army, Europe (USAREUR), staff constructing the command's rate projection model – quite understandably try to incorporate the more articulated set of numbers. Use of those numbers means the staff characterizes a theater-level force in terms of particular divisions by day. Such a method would, of course, be fine if the rates used reflected a theater force of divisions by day. Instead, the rates used are those for *individual divisions* in intense combat settings of 5 days or fewer. Given this or any command's planning need to project casualties during time of war, the following is quite conceivable: that the entire theater divisional force is assigned the same set (or

[12]We consider the tables listed for airborne and amphibious operations to be included in the category of rates for 5 days or fewer; clearly, the tables in the medical planning section are also keyed to tactical units.

sequence) of general operational postures (for example, "defense for the next 5 days"). The whole divisional force would thus be portrayed, in effect, as a single division for whatever time the postures are projected.

The second difficulty – defining even tactical rates in terms of rates for echelons below the level of focus – is illustrated by the UK case cited in the earlier section on "Sources of Point Values." The method focused on the single British corps, but achieved its rate by focusing on the combat results of battalion-size units and attempting to aggregate them across the corps by military judgment. A total casualty number was produced for the entire corps and the portion applicable to the divisional force of the corps may, of course, be stated. But the method by which the numbers were reached strongly inclines the results to reflect a lower-echelon perspective.

As we suggest elsewhere, this tendency is certainly not limited to this one instance. The set of rates currently proposed for adoption by the U.S. Marine Corps is based on a simulation of combat between forces only up to battalion level. The fact the rates this simulation has produced are so extraordinarily low – especially for a battalion-size force – is certainly an aberration from the more common experience.[13] That experience is better represented by the kinds of results seen in the Army Staff's current campaign-level simulation process, the output of which is analyzed in Chapters 4 and 6.

The third difficulty – effectively (or altogether) ignoring force size when applying casualty rates – is found in the MPM process, both the current and the proposed U.S. Marine Corps processes, and the SHAPE methodology.

[13]The simulation has apparently produced rates that show the highest daily rate for a Marine ground combat element to be 17.22/1000/day. The rates do not specify force size and are supposed to apply to any of the standard Marine ground combat elements in a given scenario. The empirical evidence shows such a rate to be significant, assuming the force to be of division size, but certainly unremarkable as a 1-day experience. Our observation of division rates in the empirical evidence has led us to view a 5/1000/day rate as a minimum significant rate. (One could easily set a lower level of significance.) One-day rates for intense division action can easily reach well beyond 20-to-30/1000/day. If the force in question is of battalion size, such a rate would be insignificant. We found rates for relatively intense 1-day engagements for battalion-size forces – both in the late-1980s at the Army's National Training Center and in World War II Western Allied data – to have a mean in the range of 160 to 175/1000/day. Median rates ranged between 132 and 157/1000/day. See our earlier report, Chapter 10, pp. 10-15 to 10-24.

Both the MPM and the Marine Corps approaches focus on rates for different levels of combat intensity. They do not specify per se the force size to which the intensity level applies. For example, the MPM process permits Army planners to use the same rate for divisions in a theater whether the theater force is comprised of 1 or 20 divisions. The Marine Corps rate methodology ostensibly uses force size as a determinant since certain scenarios suggest certain force sizes. The real key, however, is more the defined combat intensity level. A rate defined for an intensity level is used for whatever force size is employed. For example, Marine planners may apply the same rate to the ground combat elements of the Marine Corps's standard force packages of brigade ("MEB") and division ("MEF") size when given the same intensity level. That assignment approaches based on combat intensity, such as the MPM and the Marine Corps's approaches, permit distinctions between combat and support personnel in no way changes the larger point: the same rates may be used for significantly different force sizes.[14]

The SHAPE approach at first appears considerably less rigid than the MPM. It permits the planner to make several distinctions: between those combat personnel in the main operations zone (and, within that, between those on line and those in reserve) and those in a corps reserve role zone, or in the communications zone or in a strategic reserve; and in each of these zones, between combat and support personnel. Further, this method formally funnels combat personnel initially not in the forward combat zone into that zone and into enemy contact through a 30-day process.

However, the SHAPE approach fails to recognize that force size is strongly associated with a force's rate experience. The SHAPE approach shows, for example, precisely the same rates in the combat zone applying to either a single brigade, single division, single corps, or even to an entire army's-worth of divisions. The only adjustment of rates lies in the planner's choice to assign a greater or lesser proportion of the force to any one zone initially, or more or less combat force to line or reserve status, or more or fewer personnel to combat rather than support. Rates will be

[14]Once again, FM 101-10-1 may also be misused in similar fashion. It does specify divisional forces; but since it does not provide rates for lower-level units or adequate guidance on how such rates might be determined or applied, planners are likely to attempt to derive their own rates from what the manual does state. One example will illustrate the problem. We found a case in which one of the manual's rates for a given posture was tripled by the planner to attempt to account for a particular variant of that posture not described in the manual. That tripled rate was then applied in precisely the same fashion to the following: an armored cavalry regiment in that posture for a day; a division for a day because one of its brigades assumed that posture for the day; and another division for a day because the full division was determined to be in that posture.

identical for any force size as long as the planner similarly proportions the forces in terms of combat, reserve, and support elements.

Characterization of Time

Overview

Whatever the approach to characterizing force size, the role of time is a major weakness in all assignment methodologies. Every assignment methodology states casualty rates as per-day values,[15] but with a few ultimately minor exceptions, the methodologies fail to provide adequate guidance – or rates made meaningful – in terms of the passage of time.

Time is, arguably, the most abused of the critical parameters involved in providing a realistic portrayal of possible combat casualty rates. However excellent a methodology's description of a day's battle rate may be, the planner *must* have a sense of how a succession of such day-rates might realistically fit together.

Empirically demonstrated rate pulsing and variability suggest that to be credible, rate averages (means or medians) representing multiday periods must be plausible in terms of the patterns of rates likely to be seen over those periods. A value perfectly credible as a 1-day rate may be unsupportable if assigned as a daily average over 10 or more days. A rate assigned for one or a few days may in fact be far lower than the scenario and force size would warrant, and yet be implausibly high if assigned as an average over a longer time.

Comments

All the current assignment methods provide inadequate attention to time.[16] These methods include the SHAPE process, the Army's FM 101-10-1, the German process, the MPM, and the Marine Corps processes (current and proposed).

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[15]Again, the British approach mainly identified an overall number of casualties. This number can be broken into casualties for each division or organization, and those numbers can then be described in "per day" terms for the planning period.

[16]We distinguish, of course, the sets of rates and procedures this chapter describes from the particular planners or others who either use them or provide guidance for their use. The latter certainly includes individuals who understand the importance of time. Their knowledge, however, passes with their departure. Our concern is with the systems of rates and procedures that remain. We exclude the British approach with its projected single casualty number for the planning period.

SHAPE's recommended methodology attempts to avoid the issue of time altogether by providing that certain proportions of the total planning time will be spent in different postures (offense, defense, etc.). For example, the question of whether the force attacks for the first or last several days, or attacks intermittently over a period of days, is presumably avoided by merely assuming that it will in any case be on the attack (or in whatever other posture) a given percentage of the time. That concluded, SHAPE's model then takes every portion of combat force and sends it through a succession of postures for a set number of days in each posture. Thus rigidly defined, any hope of planning for a reasonable stream of casualties – given the clear importance such streams play in both personnel and medical requirements – is lost.

SHAPE's methodology does appear to permit planners to alter the number of days spent by units in the several postures. However, amending the overall length of the planning period is apparently discouraged; and, in any case, the set sequence of postures is built into the model and will function whatever the length of time assigned to each of the posture types.

The U.S. Army's FM 101-10-1 attempts to address the time dimension by allowing the planner to choose between the two basic sets of rates already mentioned. The manual informs the planner that certain rate tables apply to division or larger-size formations for periods of 5 days or fewer, and also provides other rates to cover corps or larger forces over periods beyond 5 days. The planner faced with planning for periods in excess of 5 days – the task of most planners – must either select an extremely low rate (founded on long-term average rates for large numbers of divisions), attempt to construct a scenario with appropriate postures by unit across the force by day, or attempt to construct a succession of 5-day scenarios for each division. The manual offers no guidance on how rates might look in either scenario form or successions of 5-day periods. No guidance is provided on how to guard – whether in the scenario form or the alternative sequenced-period form – against what would amount to simply stacking such 5-day (or shorter) periods back-to-back and thereby violating the manual's own guidance to use the 5-day table's data only for 5 days or fewer.

The system of rates used by the FRG contains rates keyed to postures for single-day events. However many days the planner envisions units of a certain size and type being in each posture will be the number of days those rates apply. Apparently, no guidance on time has been provided, except that rates in the first period of time

are uniformly increased to reflect a general sense that early rates will be especially heavy.

Both the MPM process and the Marine Corps processes (current and proposed) leave to the planner the determination of how long a rate – an intensity level – will last. Both processes permit the planner to apply rates, and thus to change rates, on a daily basis. The planner may apply any given rate – say, the most intense rate or the least intense rate – for as many days continuously as he chooses. However, the Marine Corps has traditionally turned to the Army's FM 101-10-1 for guidance, and appears to accept the FM's distinctions between 1-day, 5-day, and longer-term rates. Even rates as low (taken as 1-day rates for a division-size force) as those in the newly proposed system for the Marine Corps can quickly become quite significant – or excessive – if applied long enough.

Characterization of Scenario

Overview

All assignment approaches we reviewed assume (or effectively assume) a tactical scenario. The perspective and the distributions of rates characteristic of the operational level of war are essentially ignored. In those few cases in which such higher-level rates are necessary, those approaches assume that larger-scale rates can be adequately built by aggregating across an operational-level force and time period the average values that are provided for the few named tactical situations.

The methodologies appear to assume the tactical perspective because the forces of interest are usually tactical forces (corps or single divisions). Further, policy decisions – or long-standing practices – dictate that the focus will be at most on corps-size ("national") forces and that planning will be "conservative" (worst-case). Thus, in most cases, those tactical forces are set into what are deemed worst-case settings.

Certain fundamental purposes in maintaining military perspective are lost when the focus is narrowly tactical. First, sense can be made of tactical rates occurring within an operational-level setting only within that larger context.[17] And

[17]It may be that intense tactical rates could be significantly higher, on average (for a given force size, time period, and setting), when the entire operational context is merely tactical and involves relatively isolated intense engagements. See our first report, Statistical Appendix.

without that larger perspective, planners lose sight of two other concerns: the kinds of pulses of rates that will occur both in time and in some sectors, and the fact that certain operational-level scenarios (admittedly, not ones assumed in any planning scenarios) may show results for at least some tactical sectors even worse than is currently assumed to be the worst case.

Comments

Planners assigning casualty rates for U.S. Army divisional forces in the NATO context begin with a force of two corps abreast, and that force soon grows well beyond the eight divisions we use to define a minimum army-size force. Those two corps occupy a frontage as large or larger than that occupied by the entire U.S. 12th Army Group in the same area in World War II. What happens in the U.S. sector is directly dependent on what happens elsewhere along the Central Front. In every sense, this multiple-corps U.S. Army force is an operational-level force.

We have already noted how the two assignment methods in use for Army theater force planning – the MPM and those that rely on the FM 101-10-1 – permit assignment of casualty rates to the divisional portion of such a force as though only a single corps, or even a single division, were present in an altogether tactical setting. The MPM virtually requires such an approach. Characteristic of this nonspecific MPM approach is the fact that no lateral sectors of activity may currently be specified.[18] On the other hand, the field manual permits either the nonspecific approach or specification of different postures (hence, rates) for different divisions or units across the force by day. Planning systems based on the field manual may thus play out scenarios by day, which at least partially (and inadequately) allows specification of combat sectors, or simply describe the force nonspecifically by posture.

The FRG's ground forces are arrayed in three corps in separate sectors along the Central Front. German casualty rate planning is based on taking one corps, arriving at its rate (by aggregating lower-level tactical rates within the corps) for the planning period, and then assigning that rate to each of the three corps for the planning period.

Whether or not the rate reached for the single corps is reasonable, it is highly doubtful that all three corps would share that experience. As shown in previous

[18]The MPM is under review. Concern has been expressed that, in the future, its procedures should permit planners to specify lateral sectors.

chapters, the difference in magnitude between rates of worst-case corps and corps even immediately adjacent to them will be considerable. The counterpossibility, that three nonadjacent corps will each have identical rates, is far likelier for fix sectors (where rates all tend to fall into a fairly narrow, low range) than for worst-case sectors (where rates range more broadly).

Casualty rate planning often focuses on individual, seemingly separate tactical formations. Examples would be the several single-country corps such as those of the United Kingdom, Belgium, or the Netherlands. Each of those corps (with one of the German corps among them) is situated on a portion of the NATO front that since the 1950s has occupied planners' attention as a likely area for a major Warsaw Pact penetration sector. Of all the corps along the entire front, one of these is probably the most likely candidate for a worst-case situation.

As seen in Chapter 5, a breakthrough sector would in fact be centered on a very narrow sector within a single corps – probably a narrow sector straddling two adjacent divisions, either divisions in the single corps or divisions connecting two corps. The occurrence of catastrophic rates within the penetration sector will be limited to that narrow (today, one-to-two brigade) sector.[19] As also pointed out in that chapter, the results of a successful breakthrough may certainly cascade across the corps itself and to adjacent corps sectors. The breakthrough attempt will almost certainly contain the energy to push the defending corps backward. The defender's larger operational-level (multicorps) front will either break or not, and so the overall scenario will either be a disrupted front or a continuous front. However, the cascading effect of one or more breakthroughs on adjacent corps in terms of very high casualty rates follows only where the adjacent corps (or divisions from those corps) are caught in catastrophic encirclements.

Evaluating rate projections for corps astride a probable major breakthrough sector requires determinations on such considerations as just described. Yet precisely these kinds of determinations tend not to be raised when analysis focuses merely on separate tactical sectors – worse, when the tactical perspectives are low-level ones. As shown in Chapter 5, rates may be worse than the worst envisioned and

[19]Catastrophic rates in division-size forces could be seen in such operations as the Vistula-Oder campaign, where the attacking force amassed such overwhelming strength at the *strategic* level that it was able to achieve ratios of 16:1 at the *tactical* points of focus in the breakthrough sectors.

also comprise patterns of casualties entirely different than those envisioned when the tactical focus dominates analysis.

The SHAPE casualty rate projection methodology claims to apply to any scenario. Thus, as with the MPM, it does not allow for different rates by type of sector (e.g., a penetration versus a fix sector). The methodology is premised on the twin views that any force will be occupied a predetermined percentage of its time in various postures (attack, intense defense, etc.), and that the sequence, or order, of those postures over the planning period is irrelevant for planning purposes.

A planner's desire to avoid guessing which units will be in what postures on what days is, of course, understandable. Such estimates are difficult at best. However, the conclusion that a fully neutral, "scenario-less" view is either possible or useful is a large – and dubious – further step to take.

The U.S. Marine Corps's methodology approaches scenarios mainly by trying to define the intensity of combat. The still-current method uses only five standard levels of combat intensity, each with a single rate defined, and requires the planner to characterize each day's scenario by assigning an intensity level (hence rate). The proposed Marine Corps method would provide the planner three such rates for each intensity level. Both methods thus require the planner to define each day's combat intensity. In the current method, that choice equates to a designated rate; in the proposed new method, that choice is then followed by selection of a rate (from among the three possible) deemed appropriate to the setting.

CONCLUSION

Current assignment approaches to casualty rate projection do not serve planners well. The approaches vary in elaborateness but, on the whole, fail to provide planners either a healthy sense of the meaning of the rates suggested for use or the procedures for sensibly applying those rates to describe intended planning scenarios.

The current assignment approaches appear to attempt to shortcut the rigors of discerning casualty rate patterns for varying force sizes, time periods, and scenarios. We see this in such matters as their use of point rate values rather than ranges and distributions of rate values, and in their turning to lower-level units as sources of rates rather than attempting the difficult task of identifying rate patterns

characteristic of higher-level organizations and operations. Even the methodologies' dedication to conservative planning, toward which any planner naturally and properly inclines, appears too often merely to mask an avoidance of the difficulties of grappling with those uncertainties of casualty rates that to many appear to be their dominant features.

Attempts to provide planners with flexibility in defining appropriate rate projections often result in precisely the opposite: either rigid constraints on the planning process or such a lack of guidance as amounts to a nearly meaningless process. Provision of many point values for certain unit types and postures or for different levels of combat intensity may be intended to permit planning flexibility. It may as readily result in an overstated overall rate across the force without the planner having the ability to recognize either that such a rate is excessive or that the rate in question would realistically indicate an entirely different operational picture than plans envision.

As in the case of simulations, current assignment methodologies permit and even encourage rate projections inappropriate to the planner's intent and, in any case, misleading as to probable rate patterns. Rates may be projected that are as inappropriate for the stated scenario as consistent with an unintended one. But whatever the rate projected, the critical patterns of rates in certain time periods and sectors that would realistically accompany the rate are obscured. The kinds of peaks field commanders will be most concerned to avoid, or to have the capability to recover from, will be hidden during the planning stage, and thus ignored.

CHAPTER 8

CONCLUSION

GENERAL

In two related research reports, we have attempted to illustrate the character of casualty rates and patterns in actual modern conventional ground operations and to compare major current official rate projections with that empirical evidence. The contrast is significant: current projections generally fail to show either the patterns of rates that should be expected on the basis of real-world data or the magnitudes that realistically would be associated with projected forces, time periods, and scenarios.

The empirical evidence of casualty data in modern operations reveals that sense can in fact be made of casualty rates in terms of patterns. Those patterns are associated with the operational parameters of force size, time period, and scenario.

Two types of patterns emerge. The salient features of modern rates – their pulsing and variability – describe *underlying quantitative patterns* of rates that vary in terms of the three operational parameters. Those quantitative patterns enable us to describe force rate experiences by various distributions of rates and relationships among rates. Further, *patterns of operations* are exhibited in terms of a fundamental distinction between continuous and disrupted fronts. Each of these front types has generally characteristic features. Continuous fronts show multiple pulses over time (given significant continued combat), and distributions of rates across the force may be described in terms of offensive and defensive peak rate periods. Several levels of disrupted front may be distinguished by their characteristic combinations of breakthrough and exploitation phase phenomena. Ranges of peak period rates are associated with both continuous and disrupted fronts.

Thus, a force's casualty experience – and hence, its probable experiences – can be reasonably described by ranges and distributions of rates. Those patterns of rates can be evaluated in rate projections whether they are explicit (as in the case of detailed projections of rates by unit by day) or implicit (as with overall average rates).

PROJECTIONS

We extend the work of our earlier report with the following conclusions on current U.S. and Allied casualty rate projections.

U.S. Projections

Our conclusions on current rate projections by the U.S. Army and U.S. Marine Corps are the same as those in our earlier report. After delving in far greater detail than previously into projections based on calculation methods (as with the Army's Omnibus 89 simulation discussed in Chapters 4 and 6) and on assignment methods (as described in Chapter 7), we are even more confident of the strength of our earlier conclusions.

The Army's projections for a continuous-front scenario are often at least twice too high when they project a 10-day pulse (peak) period for an army-size theater divisional force in Europe. The projections also do not include the pulses of higher rates over the longer term that would characterize significant continued combat. Despite any seeming paradox, the current projections are thus too high for the currently projected peak rate (10-day) periods; at the same time, they are both too low at points along the longer time line when at least some peaks ought to be expected and too high when there ought to be intervals between such peaks. These evaluations apply to both POM/WARMAPS and OPLAN projections. The inconsistencies between these two sets of projections – one based on simulation, the other on assignment – are a further source of concern. Finally, we repeat that when rates for an army-size force on the defensive reach the upper boundaries of reasonableness for a continuous-front scenario – say, a worst-case defensive scenario at a rate of 12-to-14/1000/day – they ought to show a significant reduction in the proportion of wounded-in-action (WIA) casualties within the TBC rate. That proportion should drop from the 70-to-80 percent – seen in offensive operations and in other-than-worst-case defensive settings – to about 30-to-40 percent.

Assuming likewise that the Marine Corps ground combat element participates in a continuous front scenario in a European environment, current rate projections under the OPLAN are supportable but rates under the WARMAPS projection are inconsistent with that OPLAN projection and reach a peak magnitude that (for the measured force size and scenario) moves beyond the bounds the empirical evidence would suggest. That is, a key concern for current Marine Corps projections is simple

consistency between the two projections in terms of force sizes (populations at risk) and time periods for the subject rates. (Of course, because of the relatively small size of Marine Corps ground combat elements, the range of their possible daily rates is considerably more extensive than that for an army-size force.) Finally, as with Army projections, another concern is that neither the current nor the proposed casualty estimation methodology contains a provision, for use with worst-case settings, for altering the proportion of WIA casualties to total battle casualties.

Allied Projections

The Allies' projections are burdened by the same kinds of difficulties that attend U.S. projections. A rate that is reasonable for one force size becomes unreasonable for a force whose size is significantly different; a rate that is reasonable as a peak 10-day rate grows less reasonable as the time period extends; a rate that is reasonable for one sector may be unreasonable when applied to several sectors at the same moment; a rate that could be envisioned in a higher-order disrupted-front scenario is not reasonable for a continuous-front setting; and worst-case defensive scenarios will show a significantly reduced proportion of WIA casualties out of the total battle casualty rate.

Our assessment of Allied rate projections is included in Appendix C. Mischaracterizations of possible casualty rates are seen both in certain of the separate national projections and, perhaps especially, in the combined picture of rate projections across the Central Front region.

Common Concerns

Casualty rate projections by current calculation (simulation) or assignment methodologies share notable weaknesses.

The patterns of casualties known from the empirical evidence are usually absent from the projections. Projected rates show averages and distributions that are inconsistent with the kinds of rate pulsing and variability distinctive to modern conventional ground combat.

The absence of empirically indicated patterns in the projections applies to the underlying quantitative patterns of rates and to patterns of operational phenomena characteristic of different types of scenarios. In general, rates appropriate only for

disrupted fronts are associated with what in planning scenarios are clearly continuous-front settings.

Further, rate projections offer patterns of rates that are actually misleading. Projections will have relatively high averages (both means and medians) without including (or even acknowledging) the kinds of truly high peak rates for parts of the force that such averages in the real world would entail. Indeed, even significantly lower rate averages would be comprised in the real world of significantly higher rates in certain times and sectors than shown by the projections' higher averages.

These distorted rate patterns appear in the projections for many reasons. A key reason is that projection methodologies are dominated by a tactical perspective. That perspective tends to suggest rates – especially, but not exclusively, when the perspective is assumed across an operational-level force and time period – that are higher than is empirically supportable. Projection methodologies attempt in effect to apply mid-level or even low-level tactical rates to larger forces and time scales: simulations, by using multiples of low-level engagement results across the larger force; assignment approaches, by applying tactical rate point values across the larger force.

The task of attributing a realistic incidence of high-rate tactical experiences across a larger force is formidable in the best of circumstances. That task is nearly impossible without paying serious attention to data from the kinds of higher-level operational experiences that would provide the perspective needed to gauge the effort. Yet such inattention to the character of operational-level experience has been the rule rather than the exception for many years in methodologies supporting casualty rate projections.

Casualty rate projection methodologies have generally glossed over the phenomena of combat that lead to combat intensity being highly localized in time and place, that is, to the very reasons for casualty rate pulses and variability. That failure to heed such characteristics of operations, hence of casualty rates, has led to overlooking or misrepresenting the intrinsic connections among simple operational parameters – force size, time, and scenario – so basically associated with rates.

WHAT IS NEEDED

Projections of battle casualty rates must be grounded in a clear view of the kinds of rate ranges and patterns of rates realistically associated with various combinations of force sizes, time periods, and scenarios. Both those who project rates and those who rely on projected rates must be able, given definitions of those parameters, to distinguish credible ranges and distributions of rates. Planning should be conservative; it should not be virtually divorced from plausible operational eventualities and their rate characteristics. Otherwise, commanders may be misled as to what overall levels of personnel will remain available to them and how the severest casualty rates (some being potentially of extraordinary magnitude) will occur in localized pulses, and resource planners will be unlikely to anticipate or characterize needs reasonably.

APPENDIX A

OMNIBUS 89 "BLUE" FORCE BATTLE CASUALTY RATES

APPENDIX A

OMNIBUS 89 "BLUE" FORCE BATTLE CASUALTY RATES

We include the following time series graphs of daily casualty rates as produced by an official campaign-level simulation, the Concepts Evaluation Model (CEM), in use by the U.S. Army Staff. These rate curves were produced in a particular run of the model, supporting a Staff "capabilities" study entitled "Omnibus 89." The curves are unique to that run of the simulation, but are probably fully representative of rate curves produced in other runs as well.

These rate curves are shown so that their character may be compared with empirical rate curves published in our first report. As in Appendix B of that first report, the curves show total battle casualty (TBC) rates per 1000 division-level personnel per day.

Rate curves for the simulated "Blue" force – U.S. and Allied divisions – are displayed in this appendix. Curves for the simulated "Red" force – Soviet and Warsaw Pact divisions – are displayed in Appendix B.

The graphs are arranged again by echelon (army, corps, and division). In order to maintain the unclassified status of the data as provided to us by the Army, the echelons are identified with the same unclassified codes assigned by the Army (with, in some cases, further measures as an extra precaution).

Army and corps rates represent the average (mean) rates for all divisions assigned that day to the particular army or corps. (The simulation does not represent nondivisional personnel.)

An "army" is a NATO formation (Central Army Group or Northern Army Group) or the collection of U.S. divisions (termed "U.S. Forces") sufficient to equate to an army-size force, or is a model-created army.[1] (Since the U.S. divisions are assigned to NATO control, no such actual army exists in the simulation; instead, U.S.

[1]The model "creates" armies and corps when certain rules are met. These are termed a "created army" or a "created corps."

divisions are subsumed under the NATO Armies A and B.) We have also calculated the rates for all NATO divisions as a single entity, termed "Total Force."

Listed corps include the eight well-known national corps organizations: U.S. V and VII Corps; German I, II, and III Corps; Belgian I Corps; British I Corps; and Netherlands I Corps. Their identities and order are coded. Three "created" corps are also listed.

To facilitate comparison with the empirical casualty rate curves provided in our first report, the X-axis in these graphs is identical in length to those curves' axes. Only 60 days of simulated data were provided us. Thus, each curve shows 60 data points along a 280-day axis.

In order to facilitate comparisons, we wished to use identical ordinate axes as well. Thus, all Blue curves are first shown using the three Y-axis heights used in the empirical data: 25 for army curves and 50 for both corps and division curves. However, since in many cases these axis values would not contain the simulated rates, we have also displayed some curves using a "simulation scale" which contains nearly all the simulation's rate observations (for Blue forces): 40 for army curves and 80 for corps and division curves. For each curve, the empirical scale is first shown; if too many simulation data points are therefore excluded, the curve is again displayed using the "simulation scale."[2]

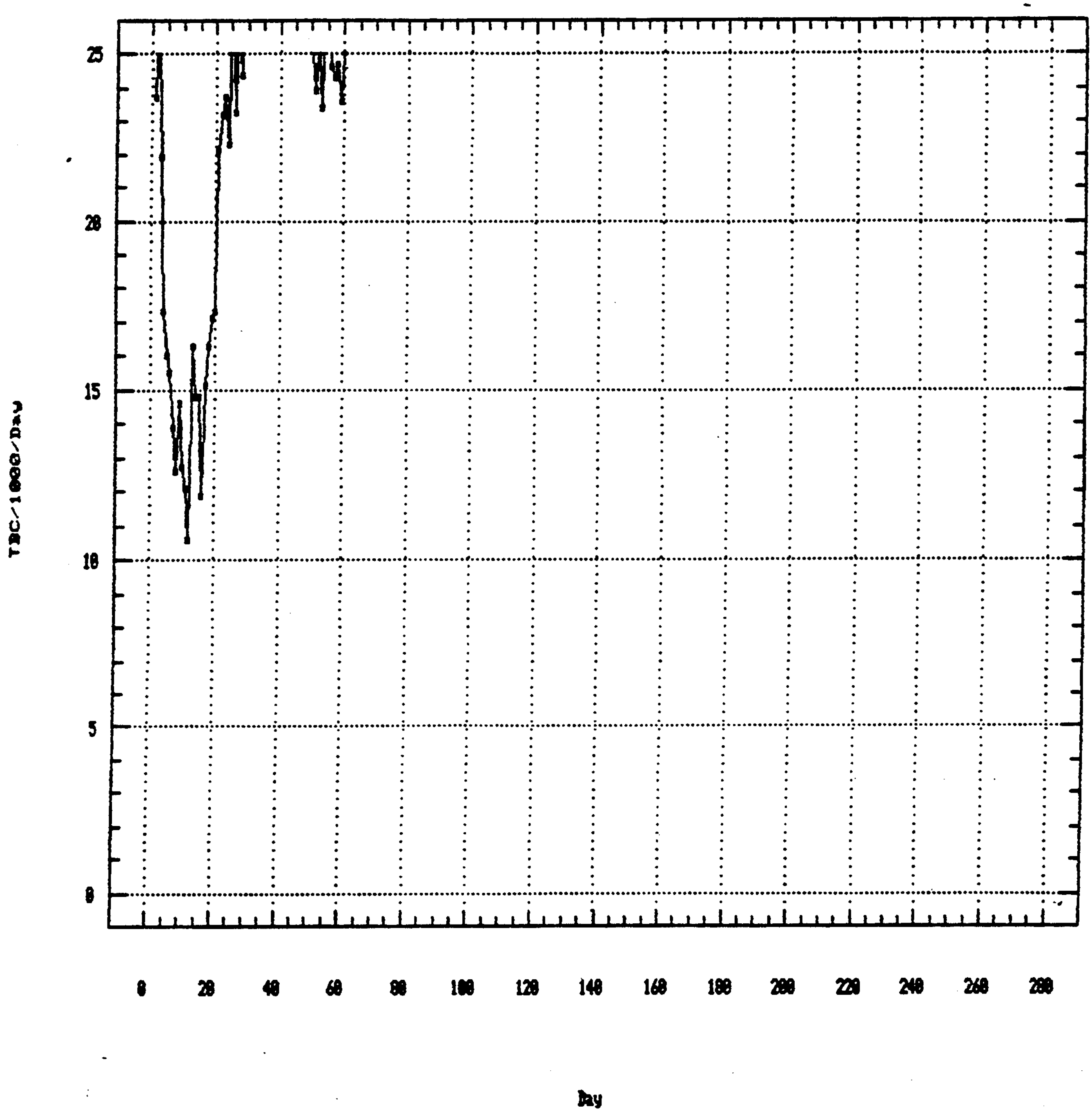
[2]Note that Appendix B shows that the "simulation scale" for Red forces is yet higher.

BLUE ARMY GRAPHS

(Pages A-7 to A-16)

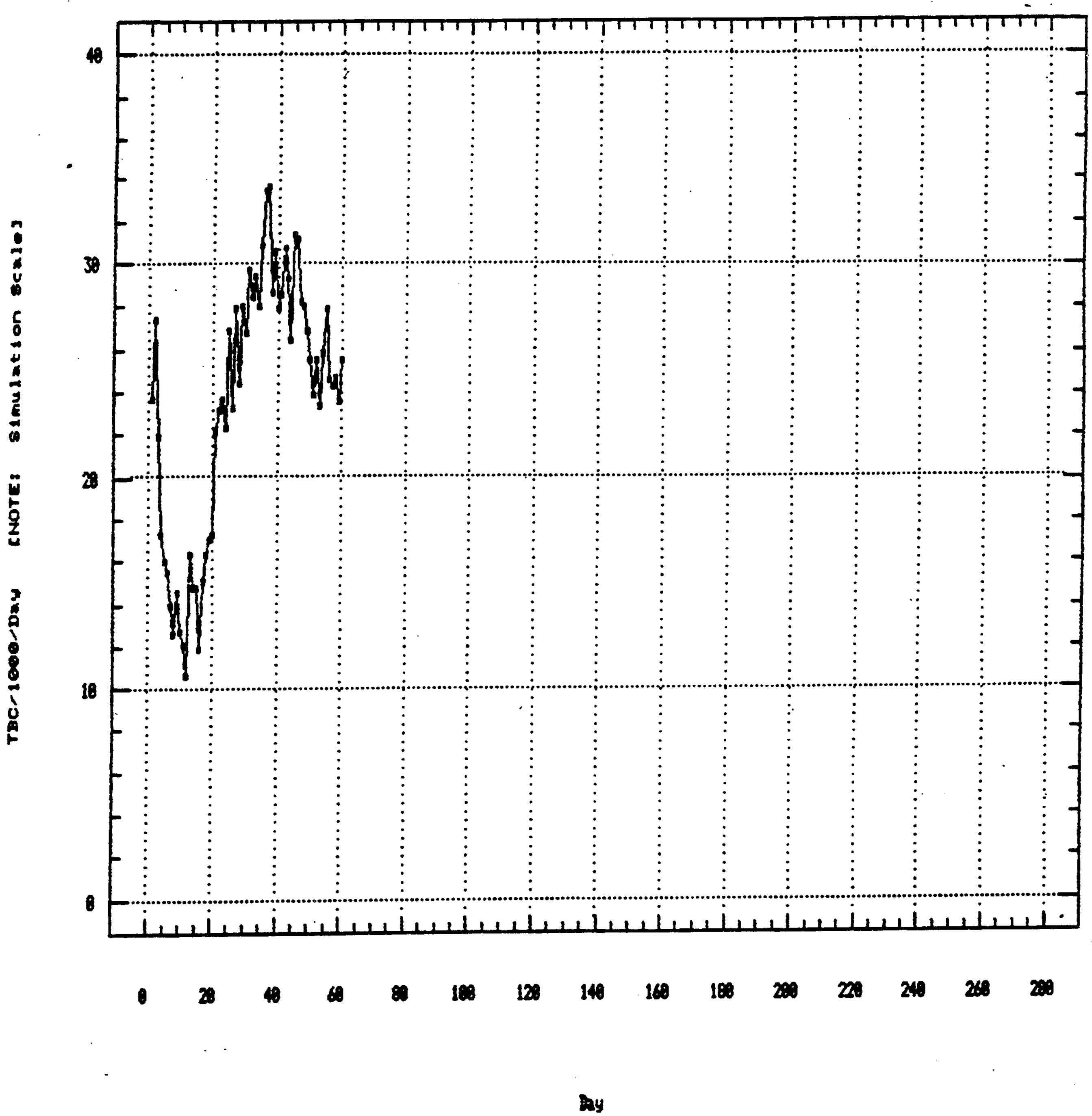
Total Force

(Average Daily Division-level Rate)



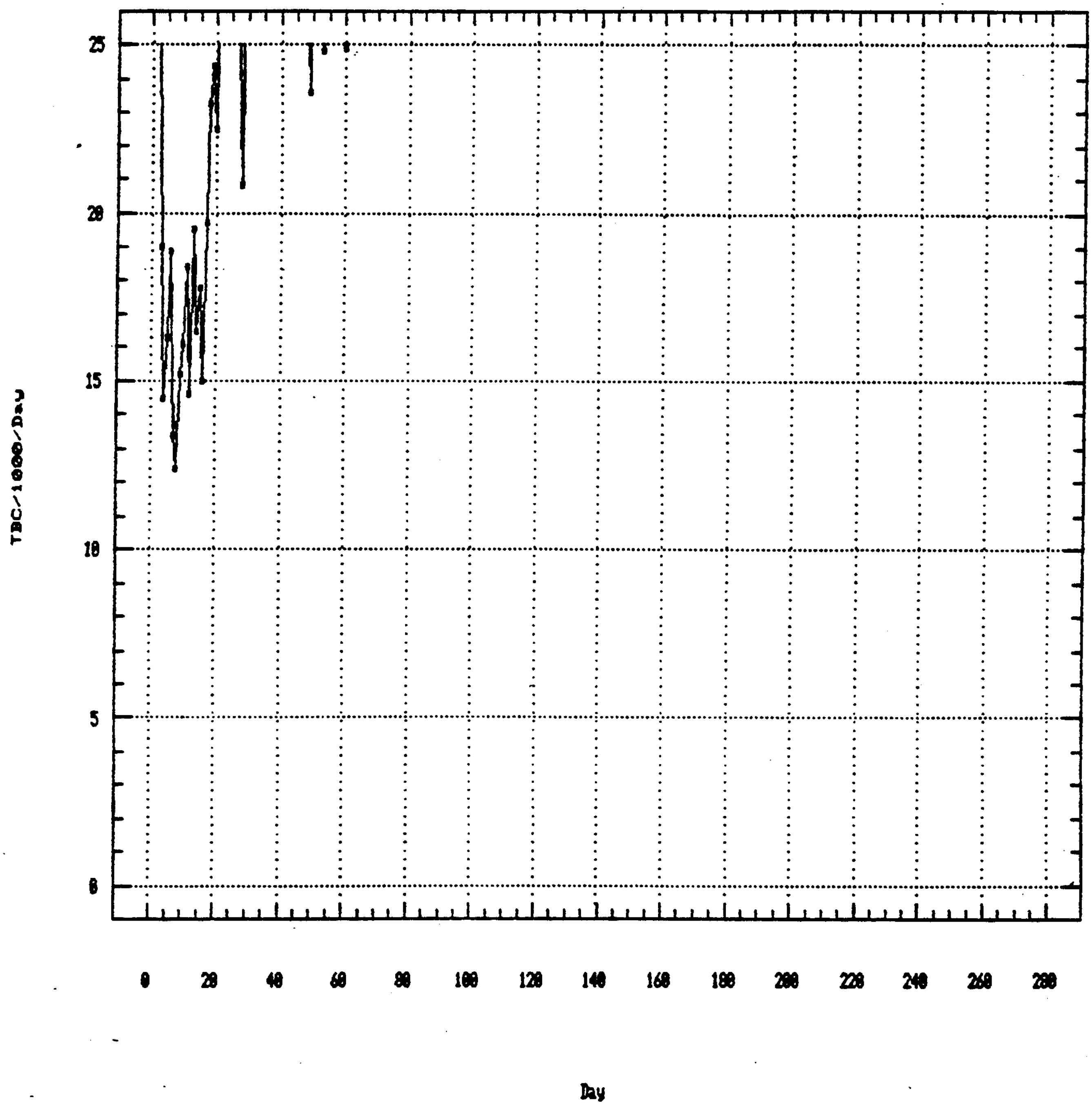
Total Force

(Average Daily Division-level Rate)



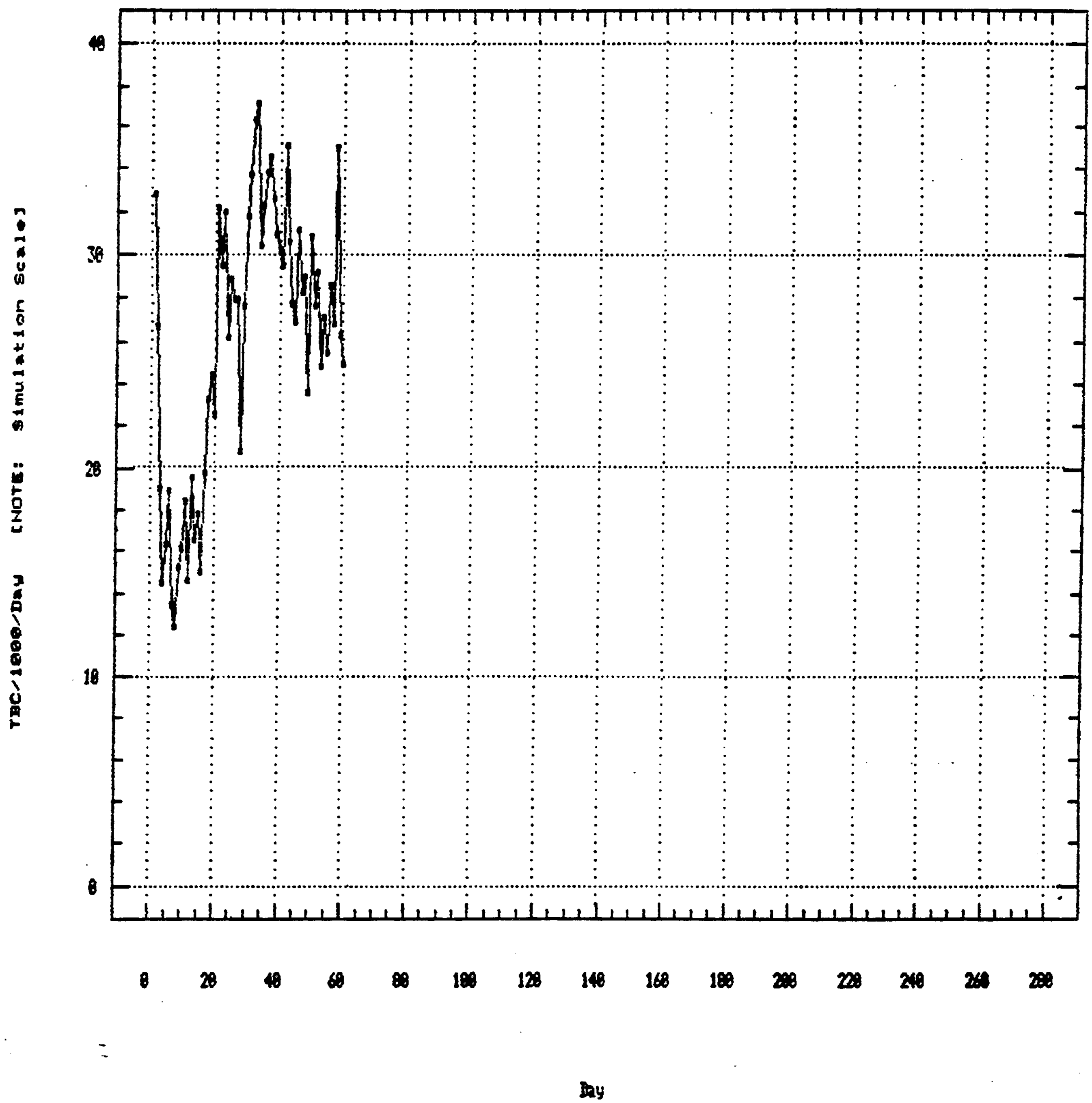
Army 'A'

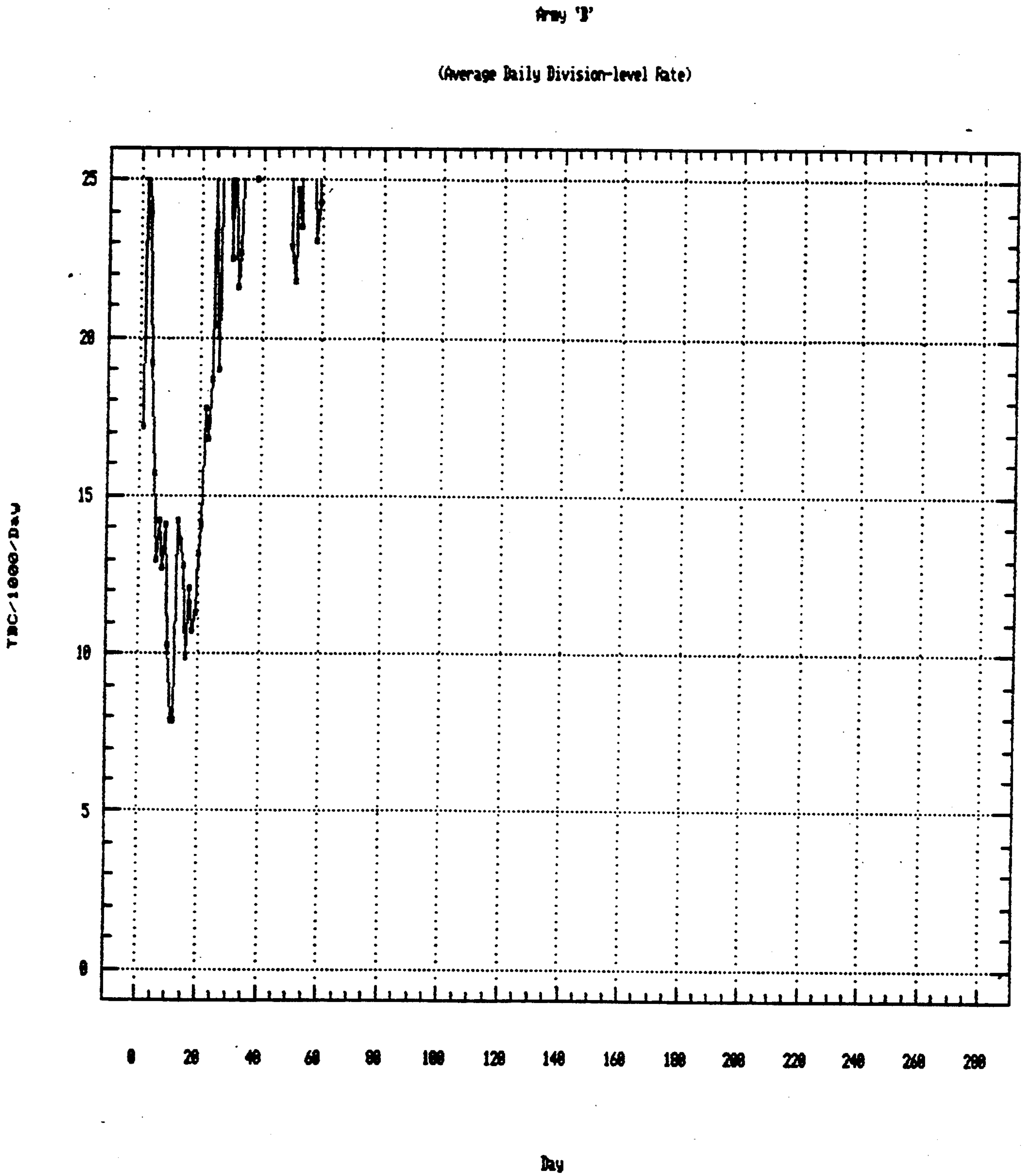
(Average Daily Division-level Rate)



Army 'A'

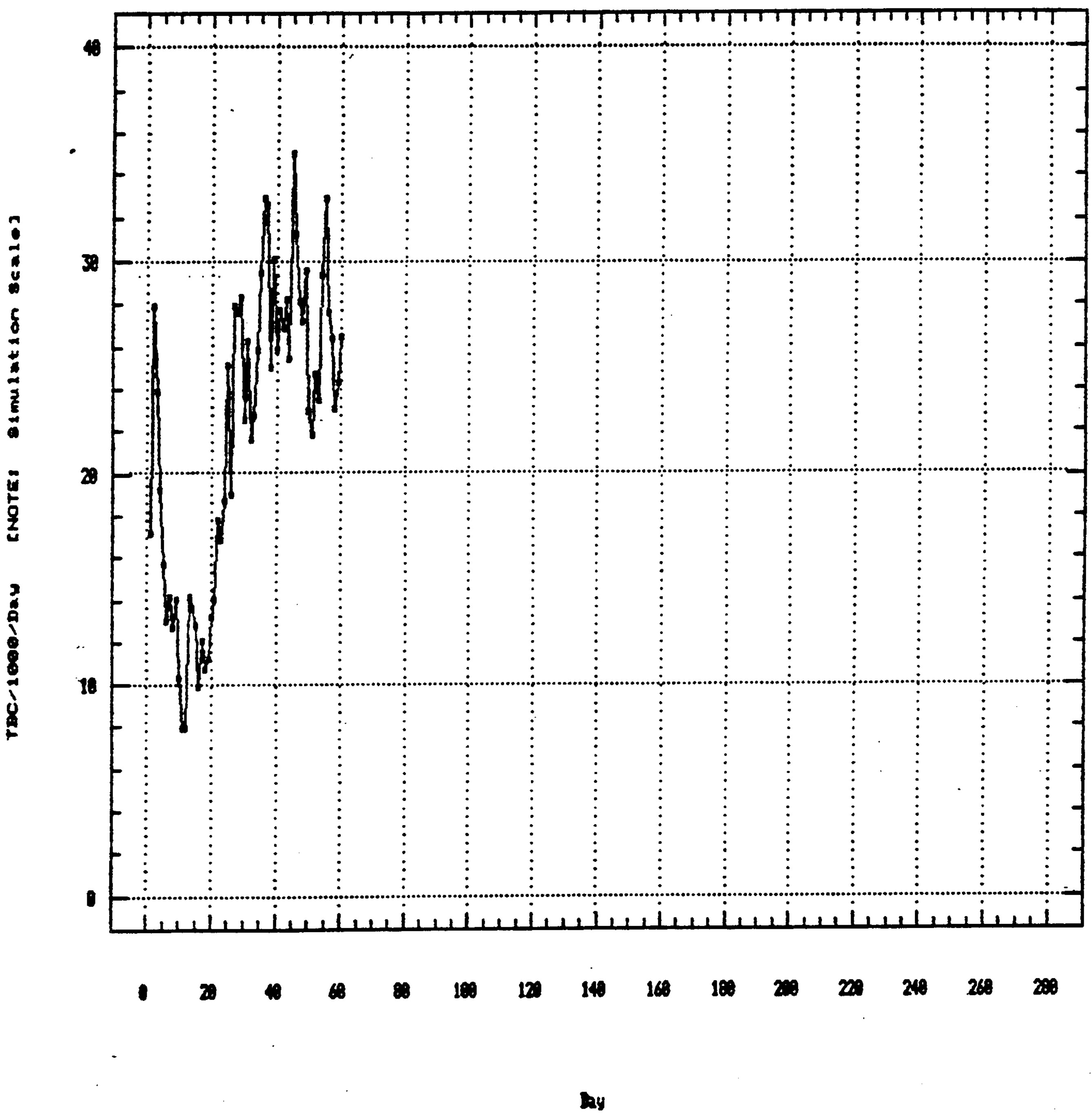
(Average Daily Division-level Rate)




Army 'B'
(Average Daily Division-level Rate)
TBC/1000/Day
25
20
15
10
5
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

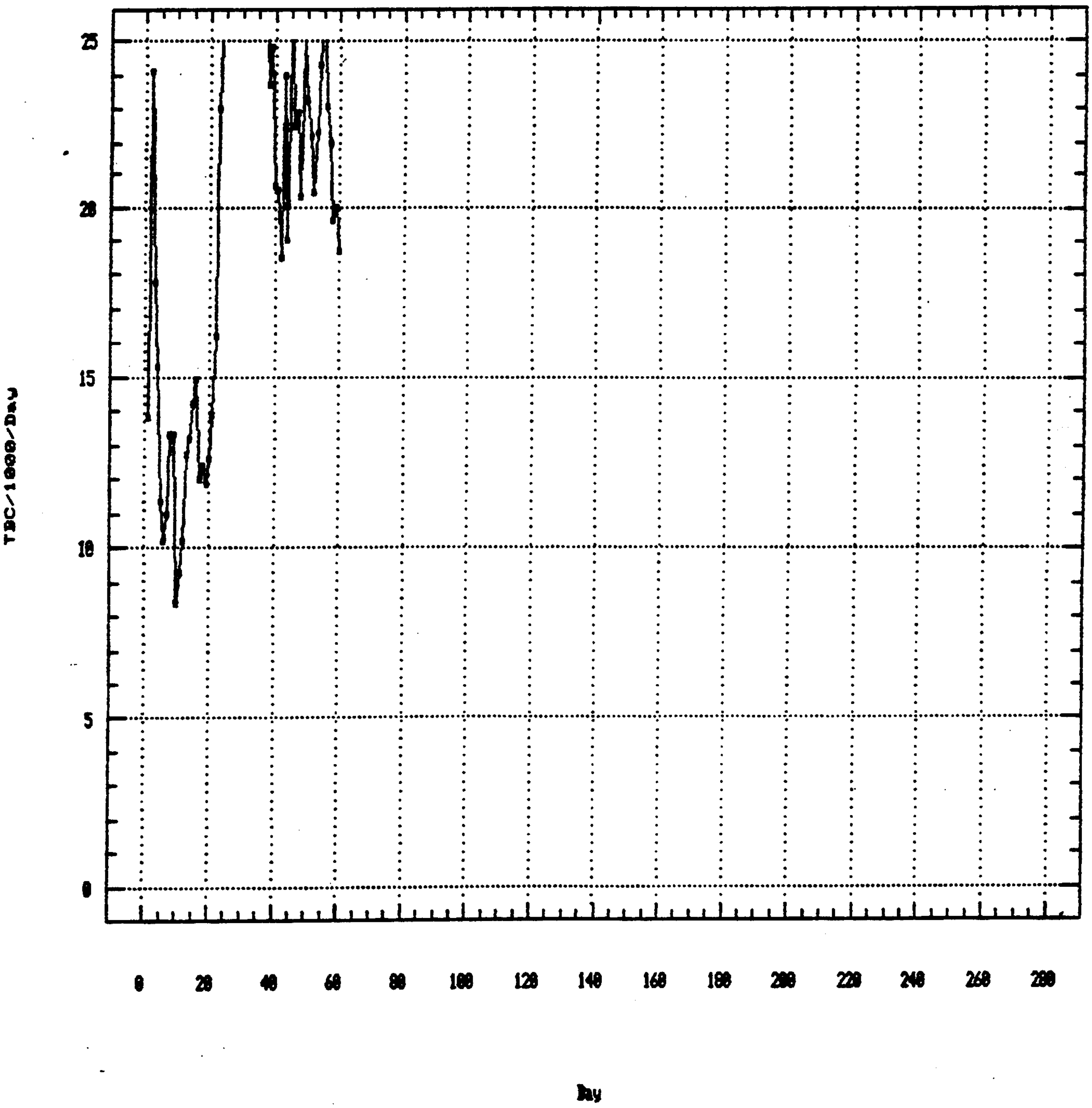
Army 'B'

(Average Daily Division-level Rate)



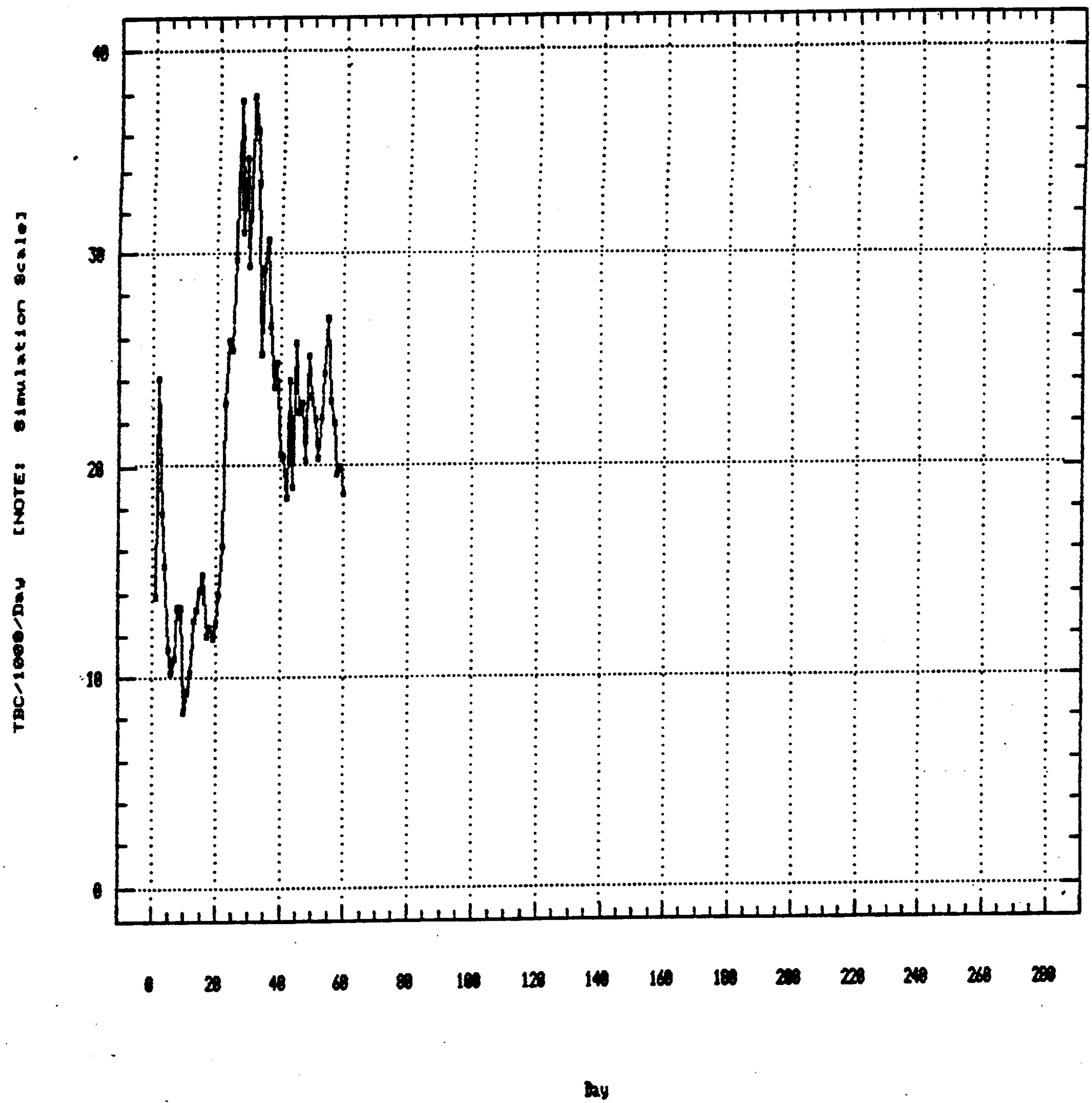
Army 'US'

(Average Daily Division-level Rate)



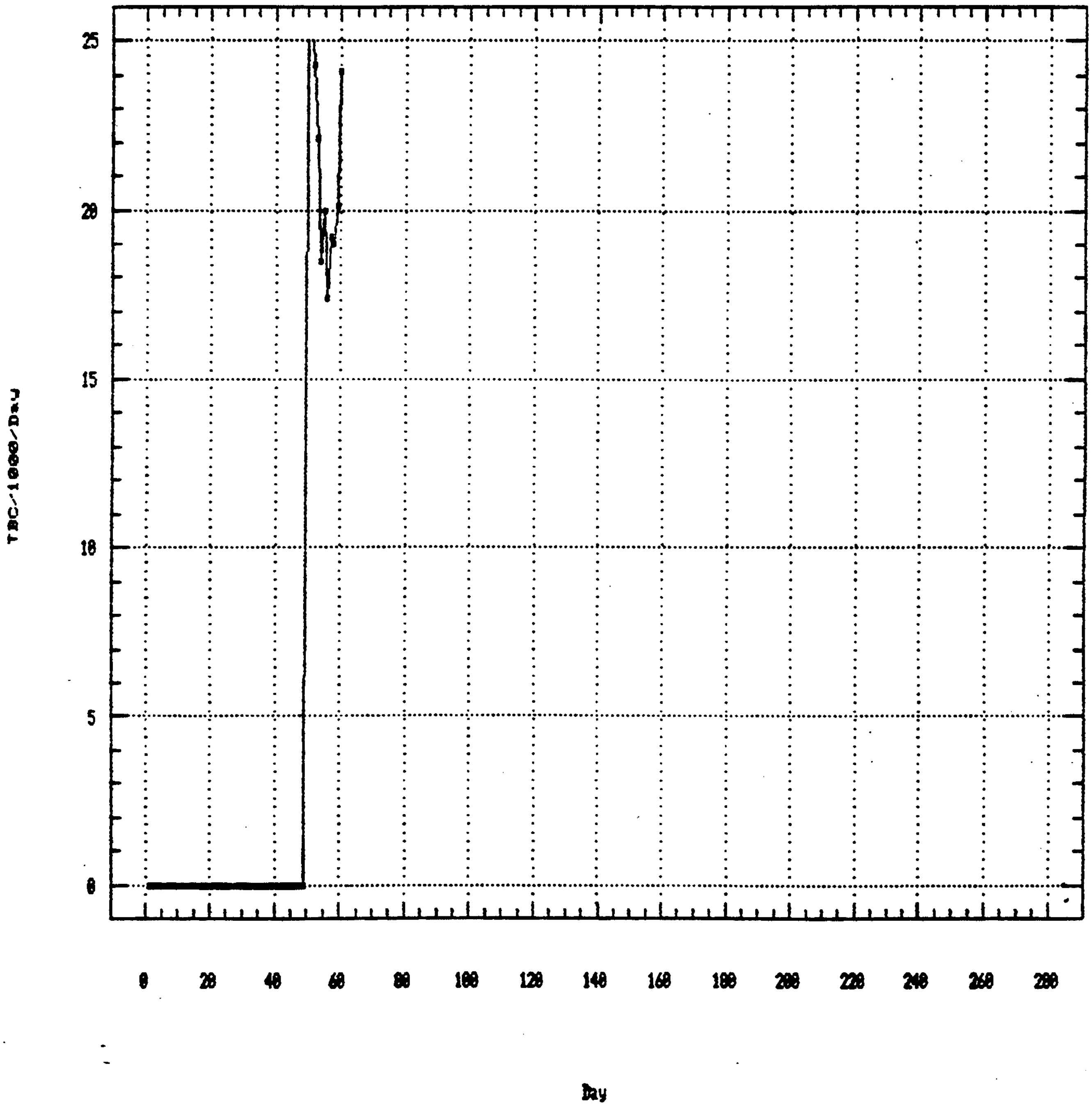
Army 'US'

(Average Daily Division-level Rate)



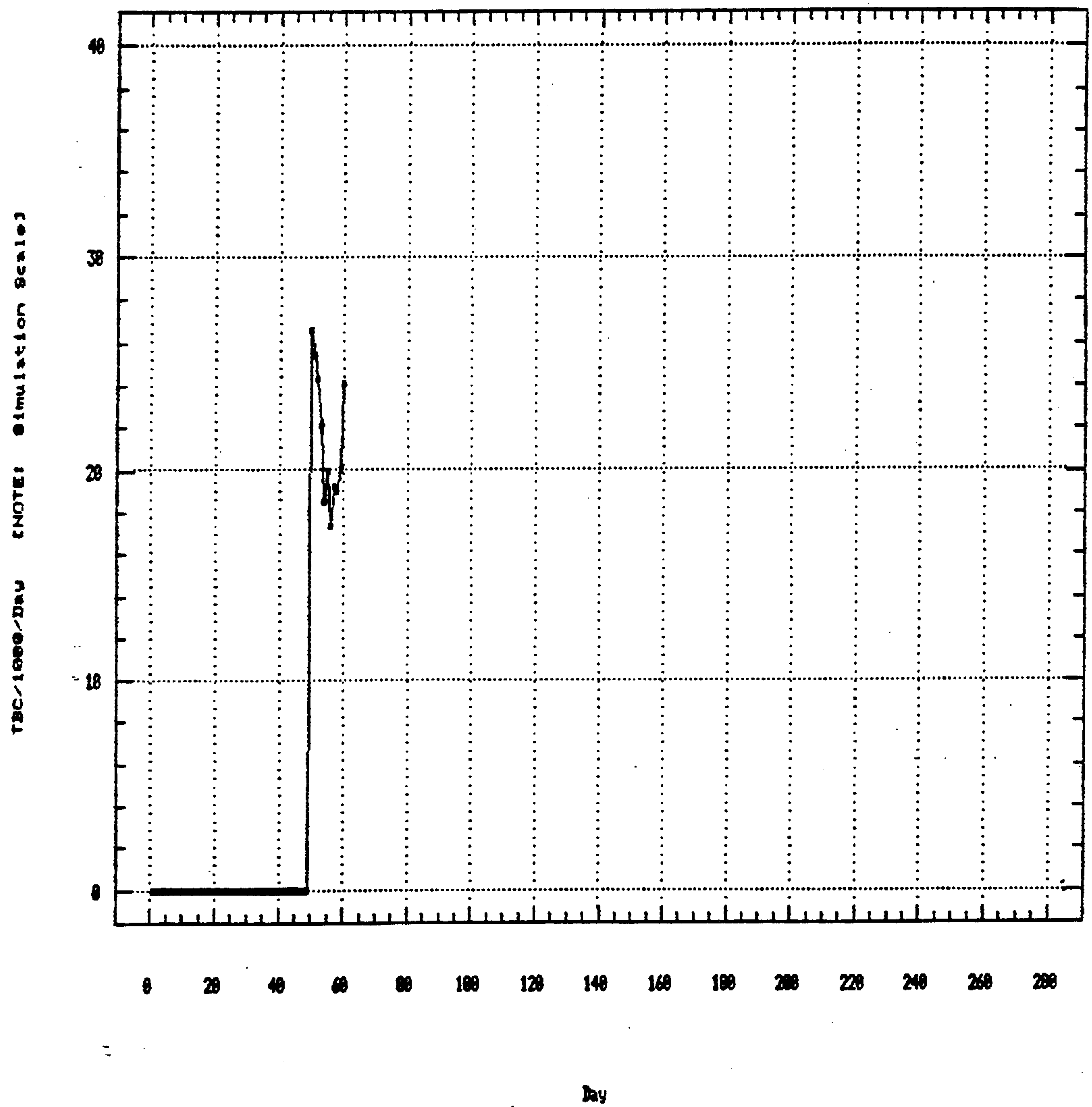
'Created Army'

(Average Daily Division-level Rate)



'Created Army'

(Average Daily Division-level Rate)

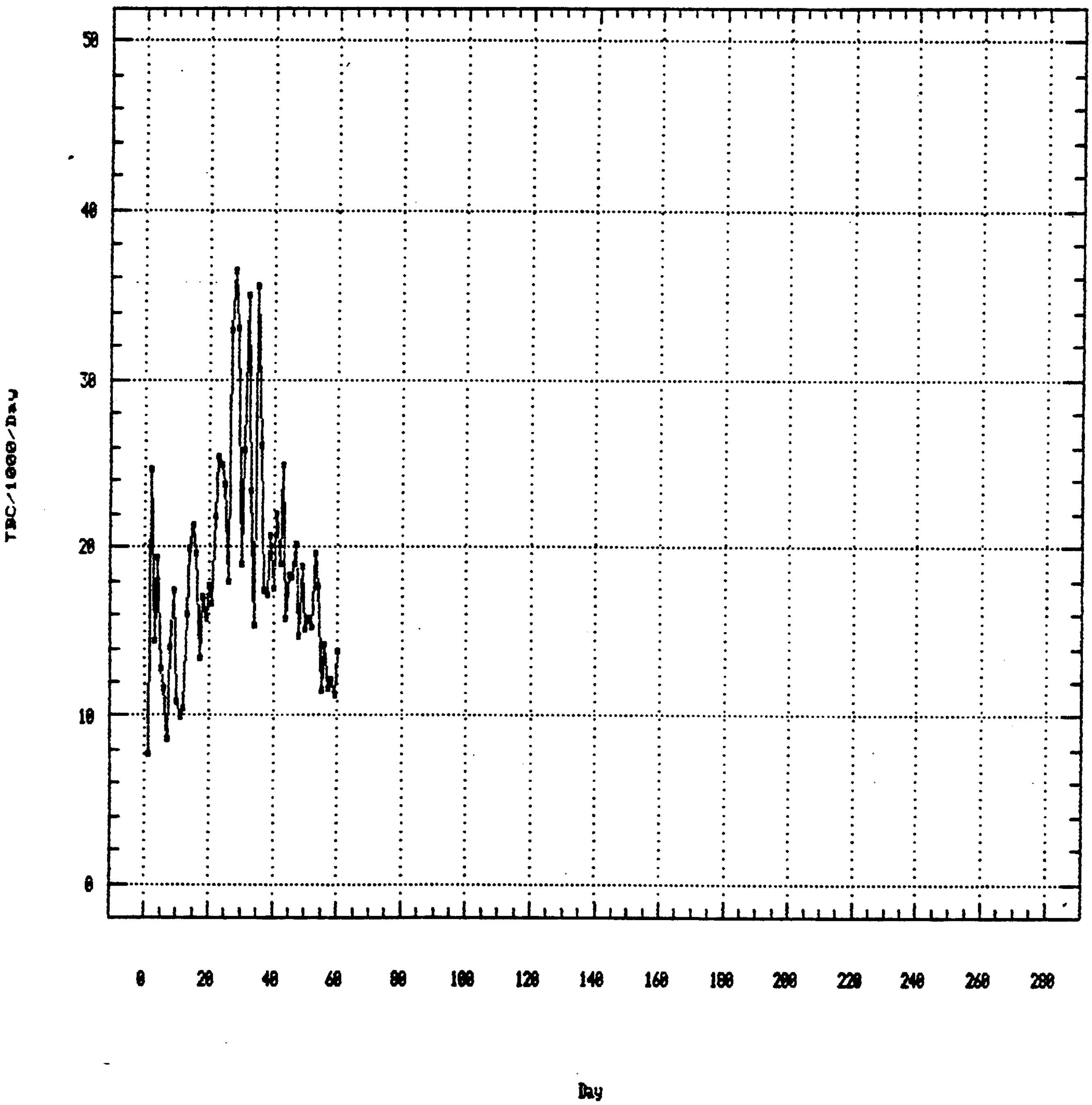


BLUE CORPS GRAPHS

(Pages A-19 to A-31)

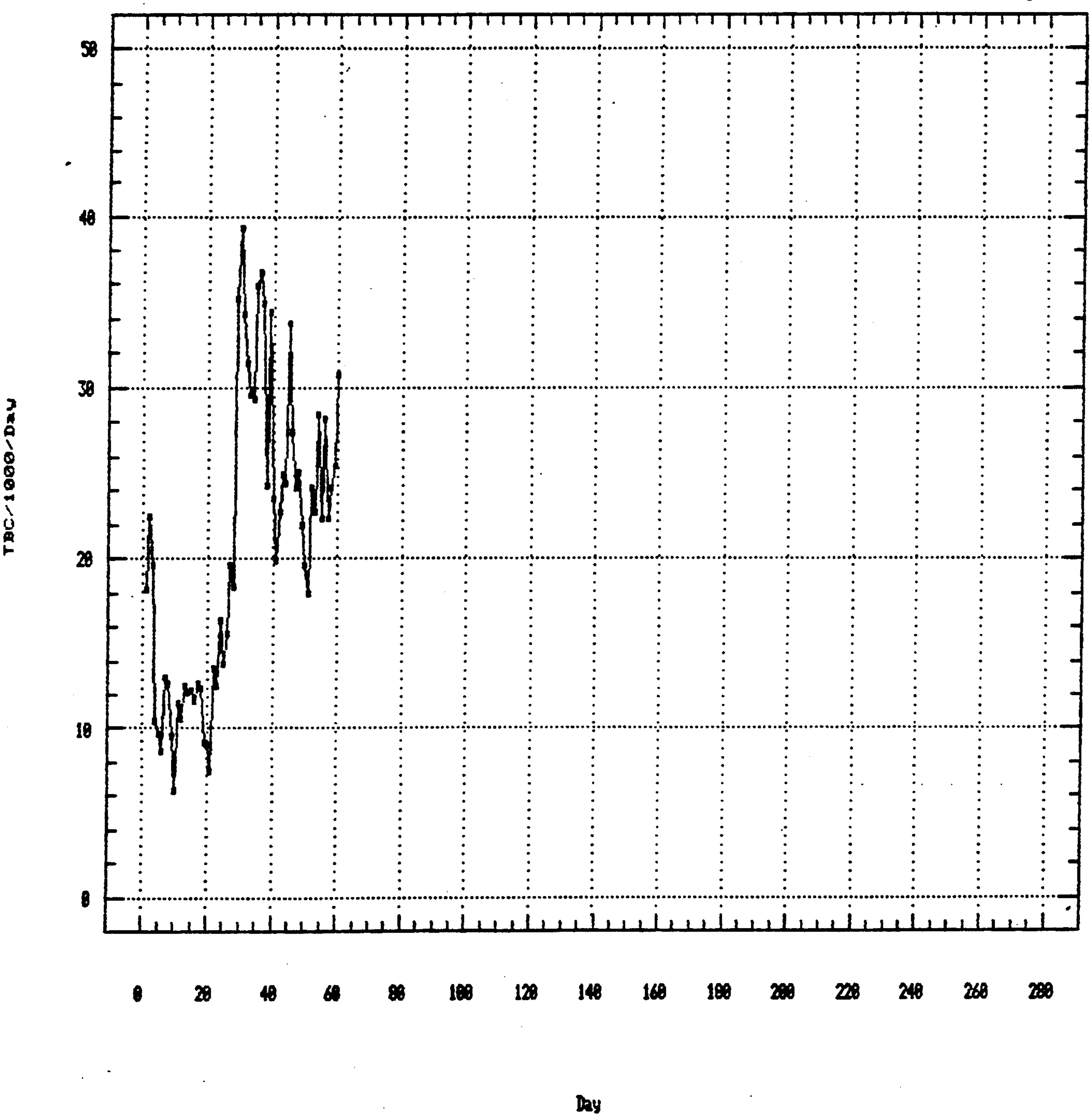
Corps 'D'

(Average Daily Division-level Rate)



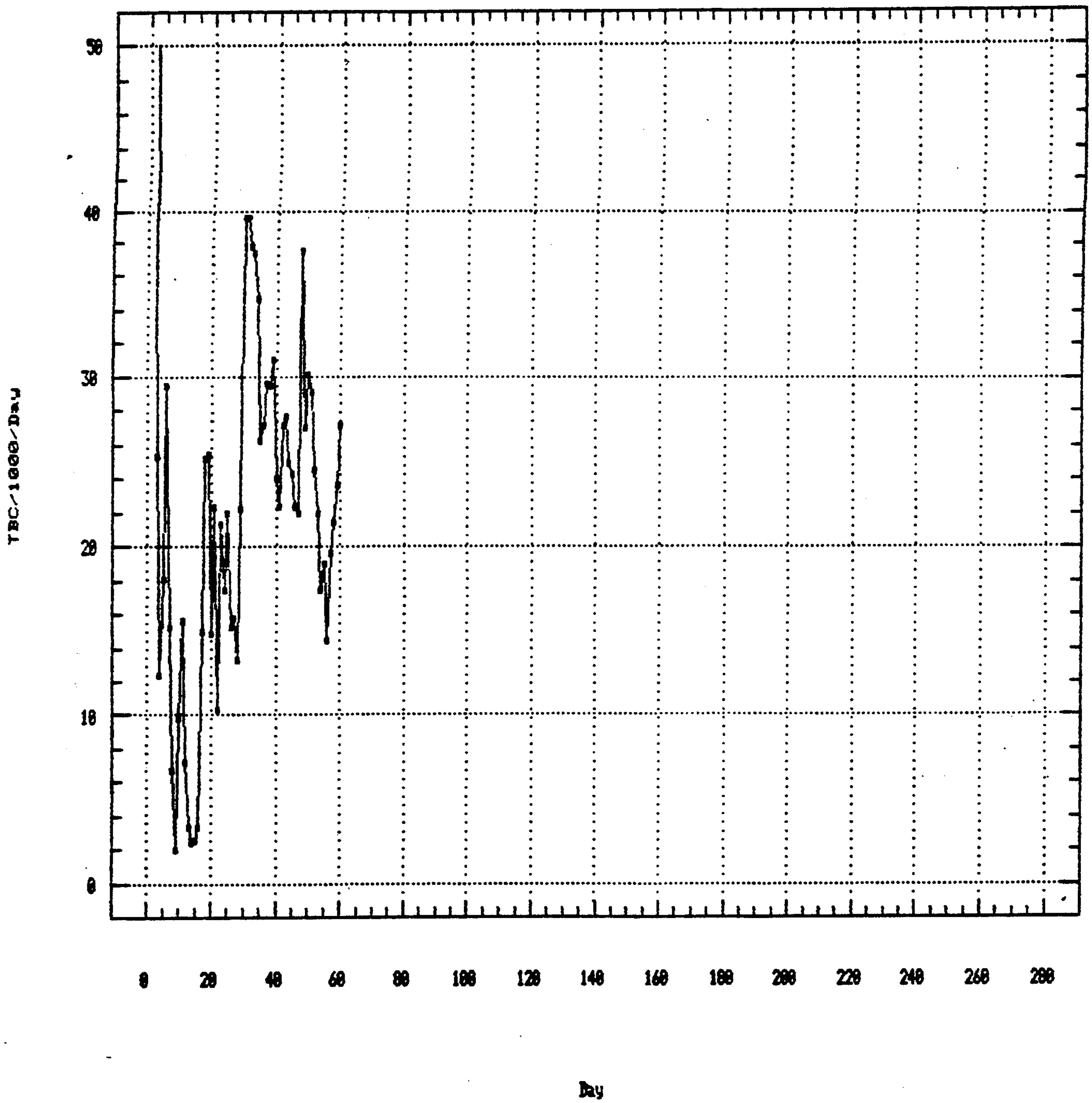
Corps 'E'

(Average Daily Division-level Rate)



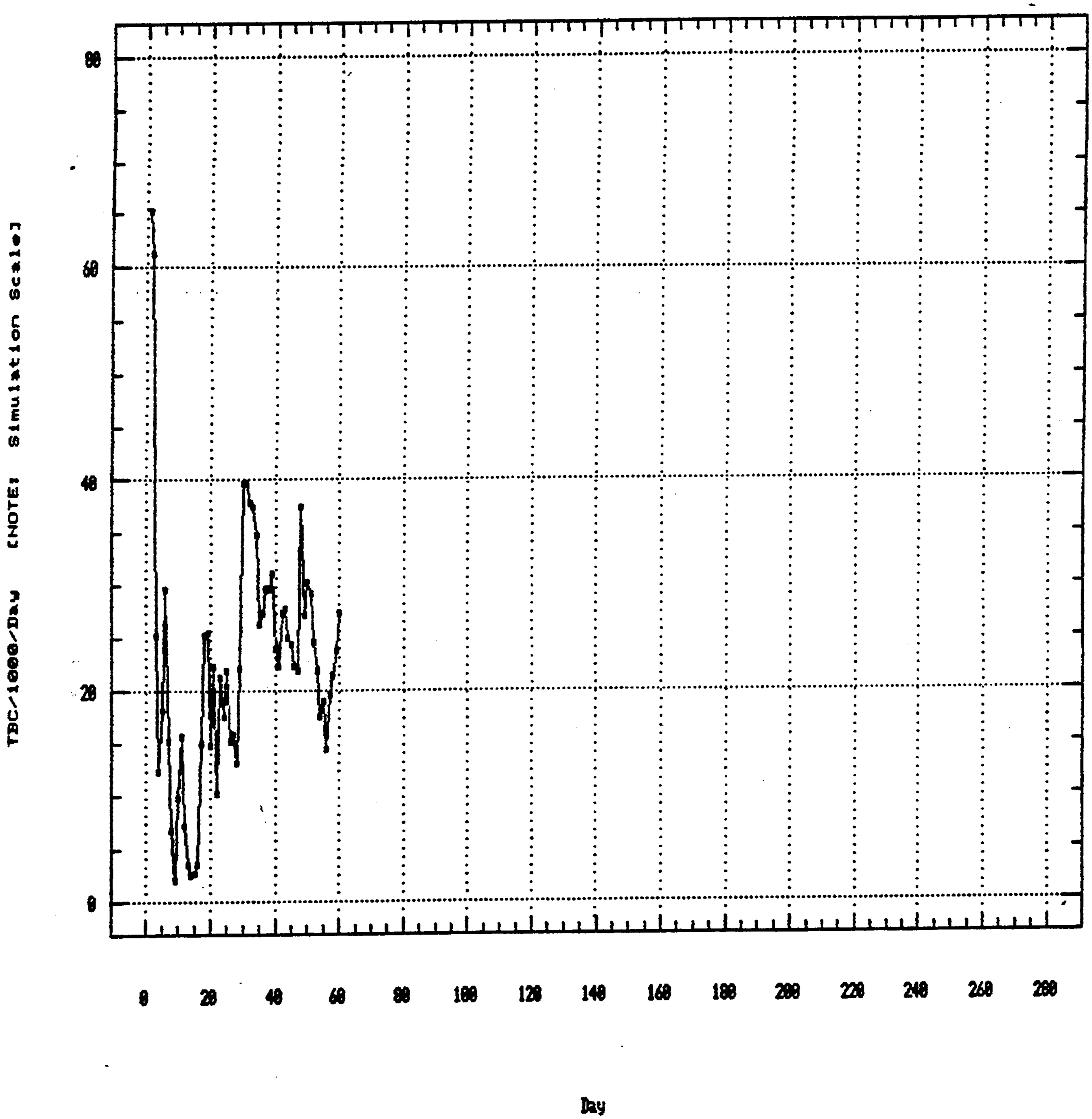
Corps 'F'

(Average Daily Division-level Rate)



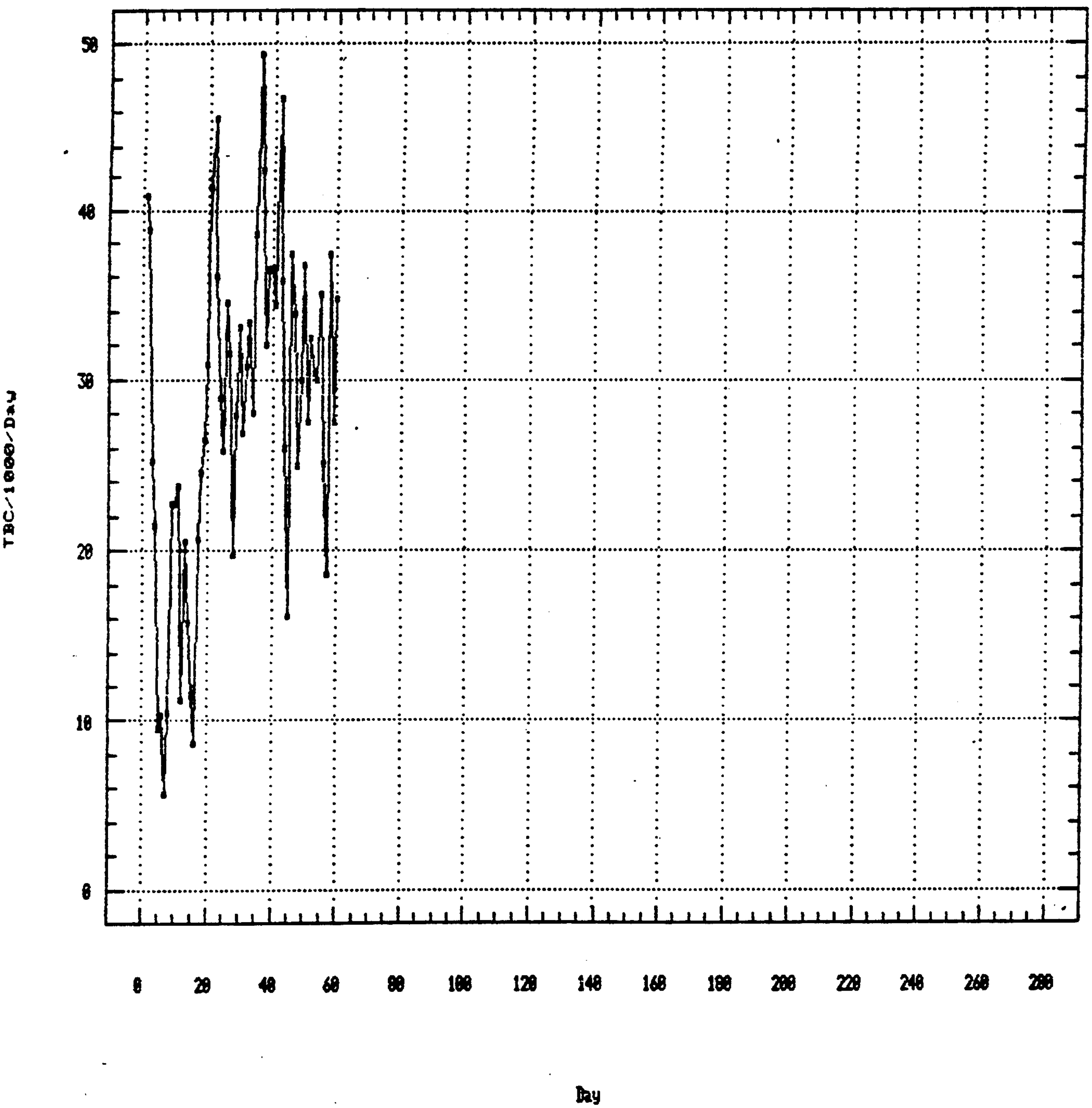
Corps 'F'

(Average Daily Division-level Rate)



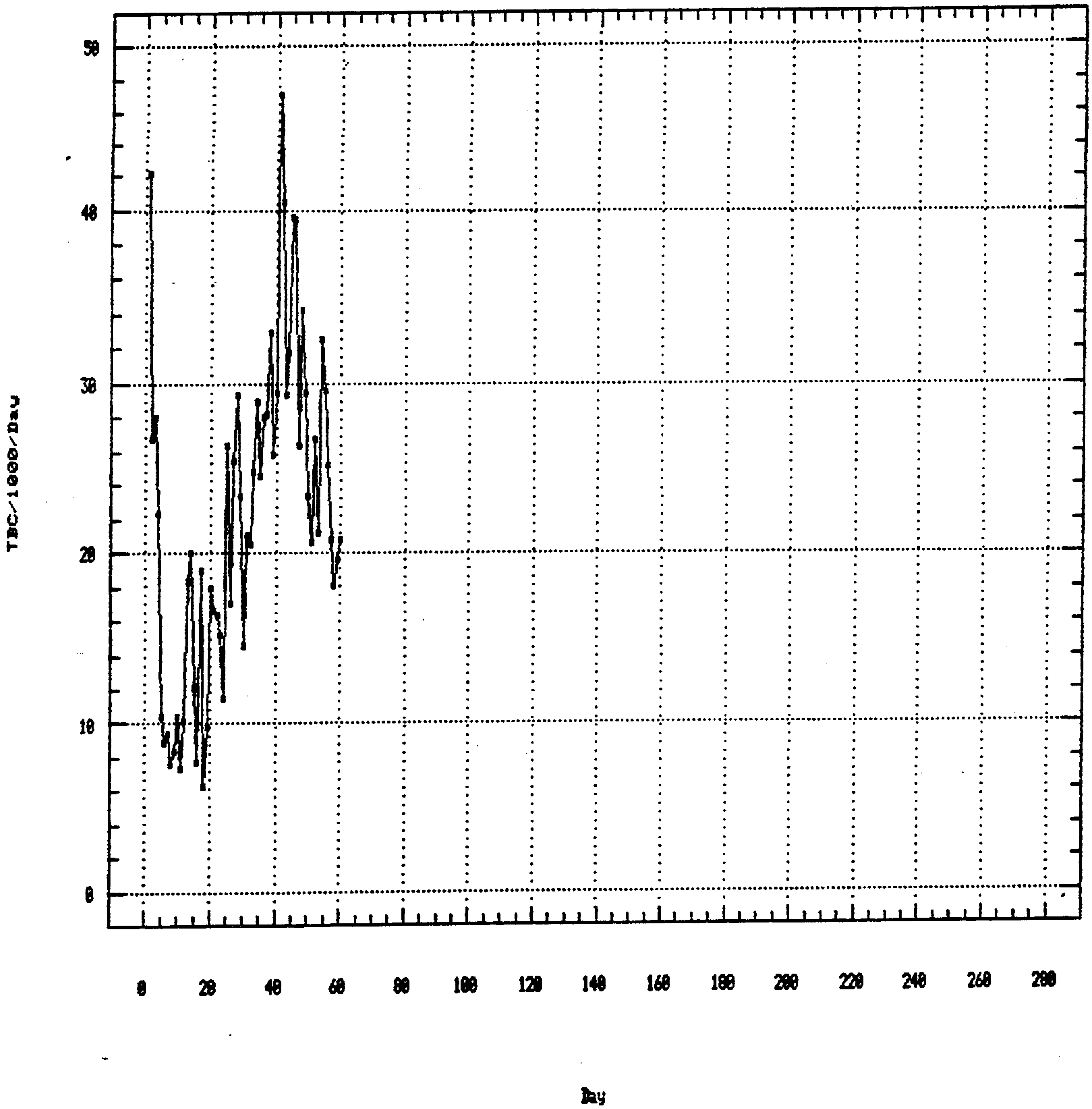
Corps '6'

(Average Daily Division-level Rate)



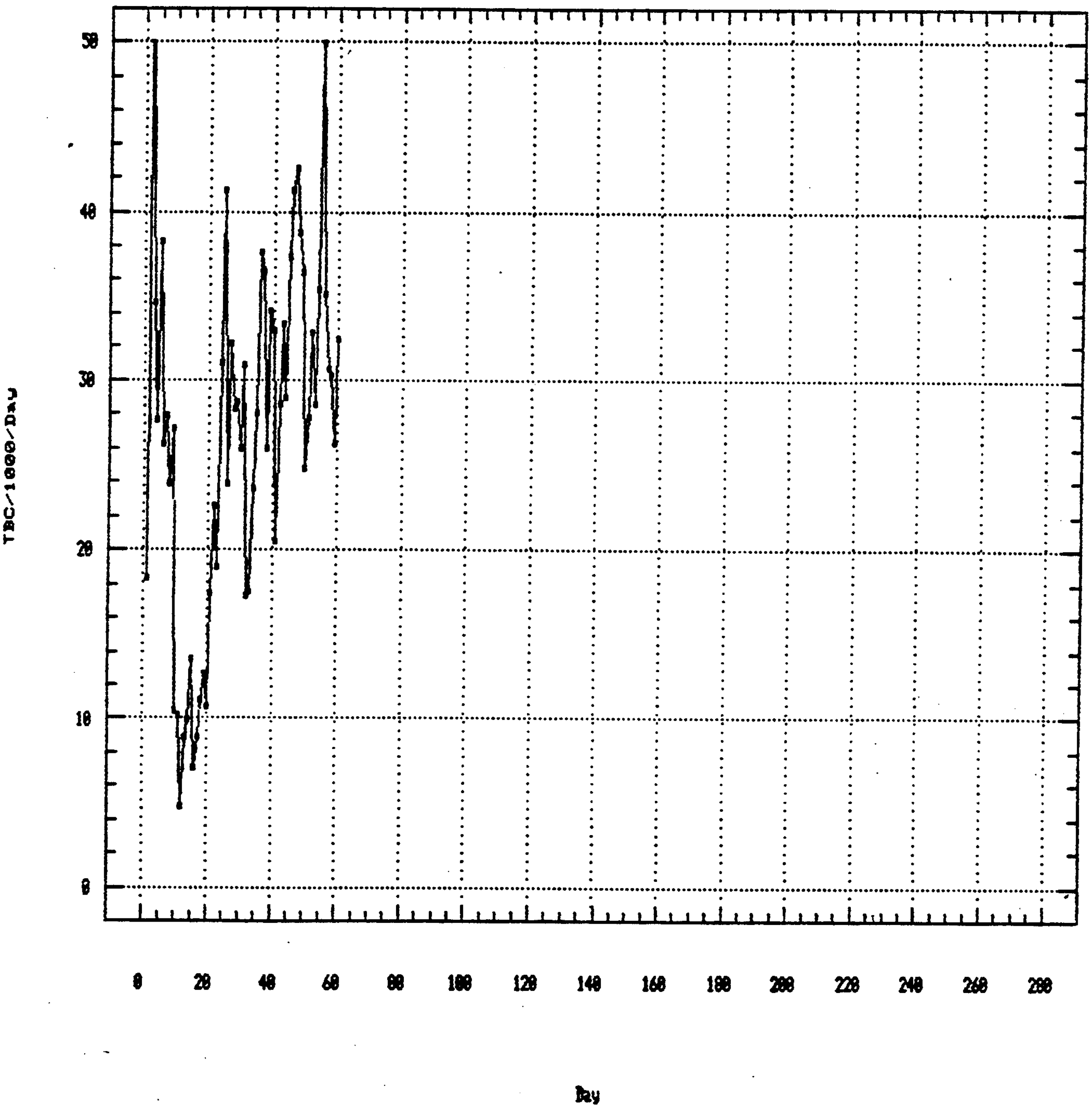
Corps 'H'

(Average Daily Division-level Rate)



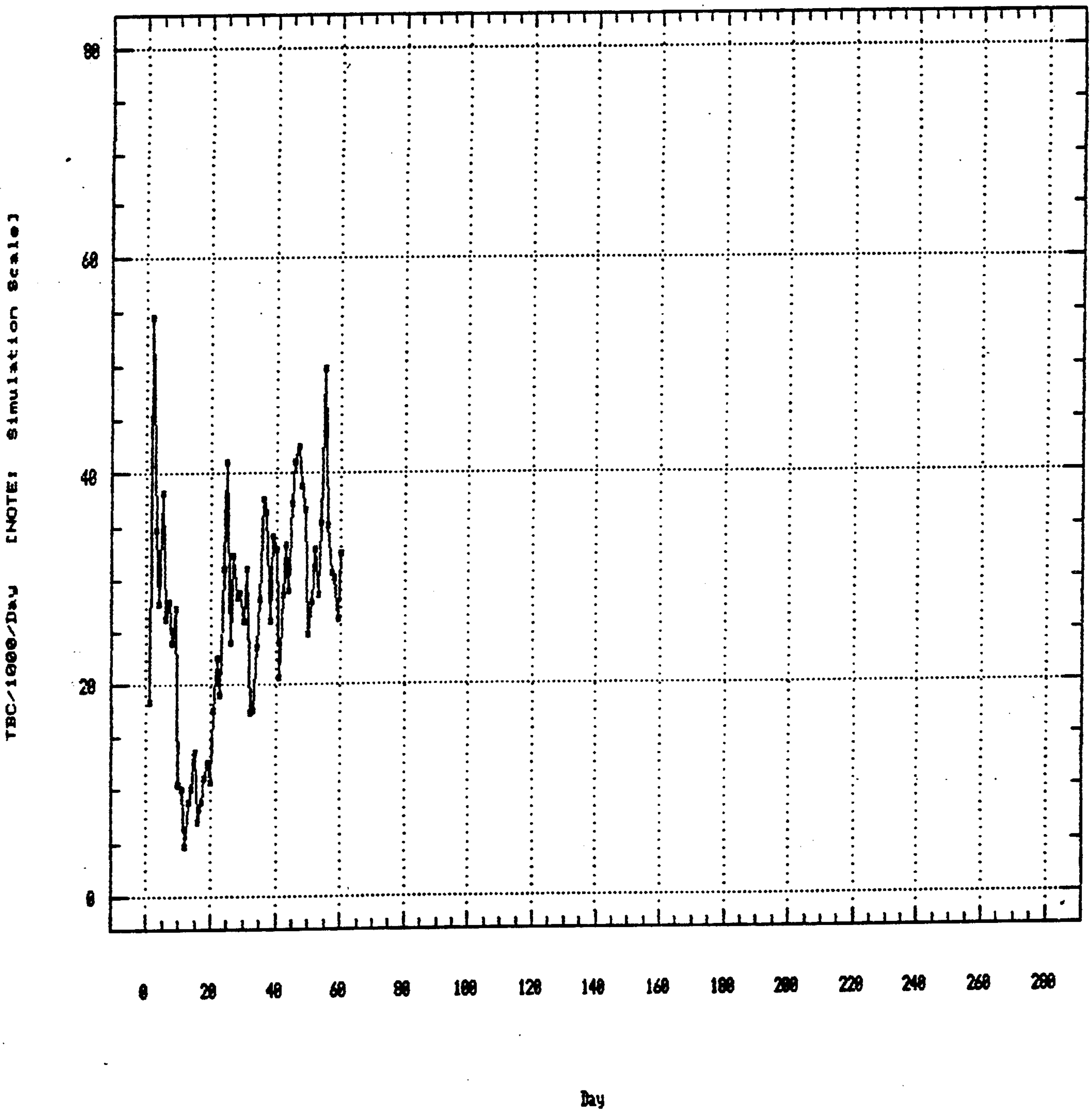
Corps 'I'

(Average Daily Division-level Rate)



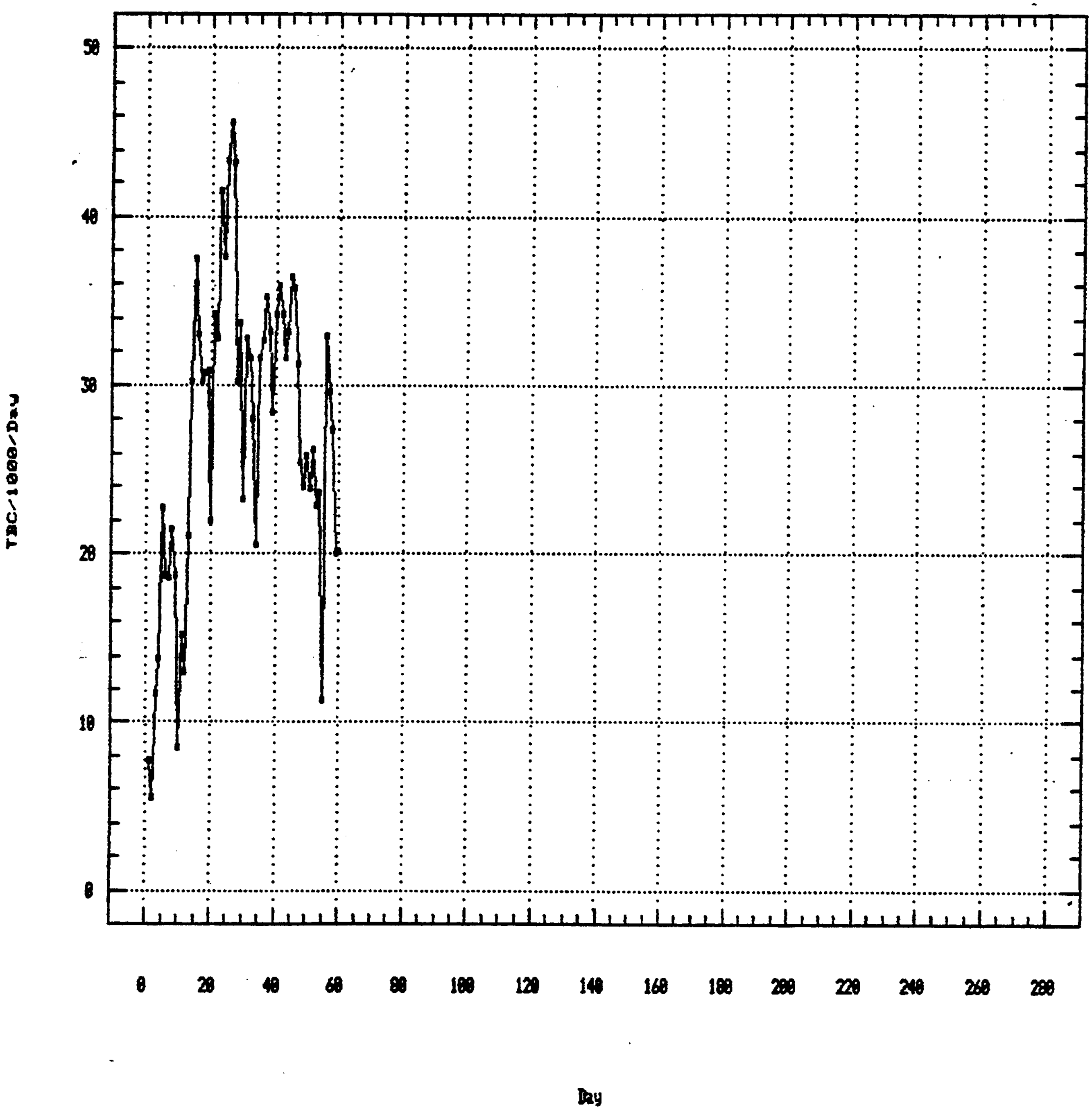
Corps 'J'

(Average Daily Division-level Rate)



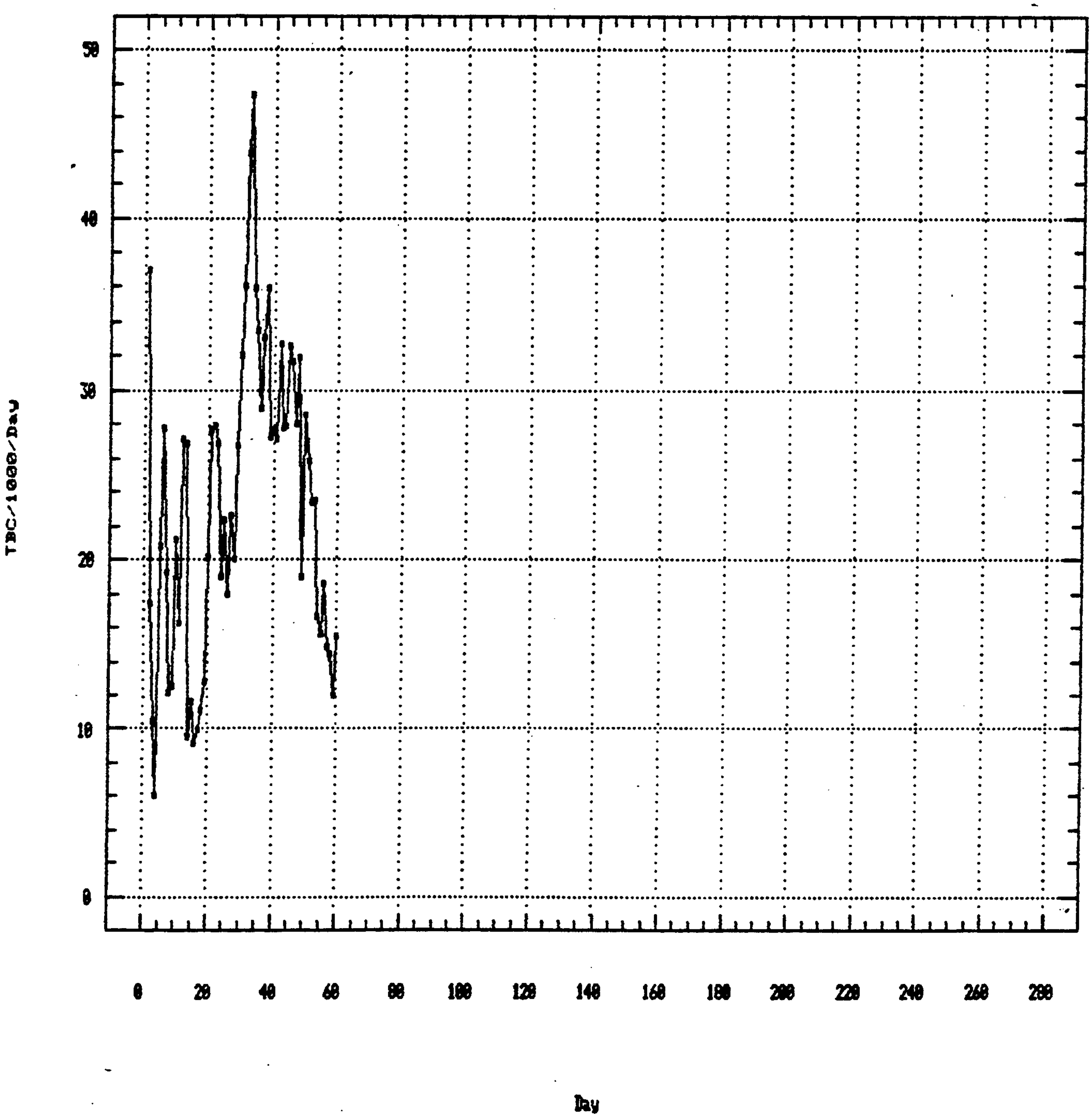
Corps 'J'

(Average Daily Division-level Rate)



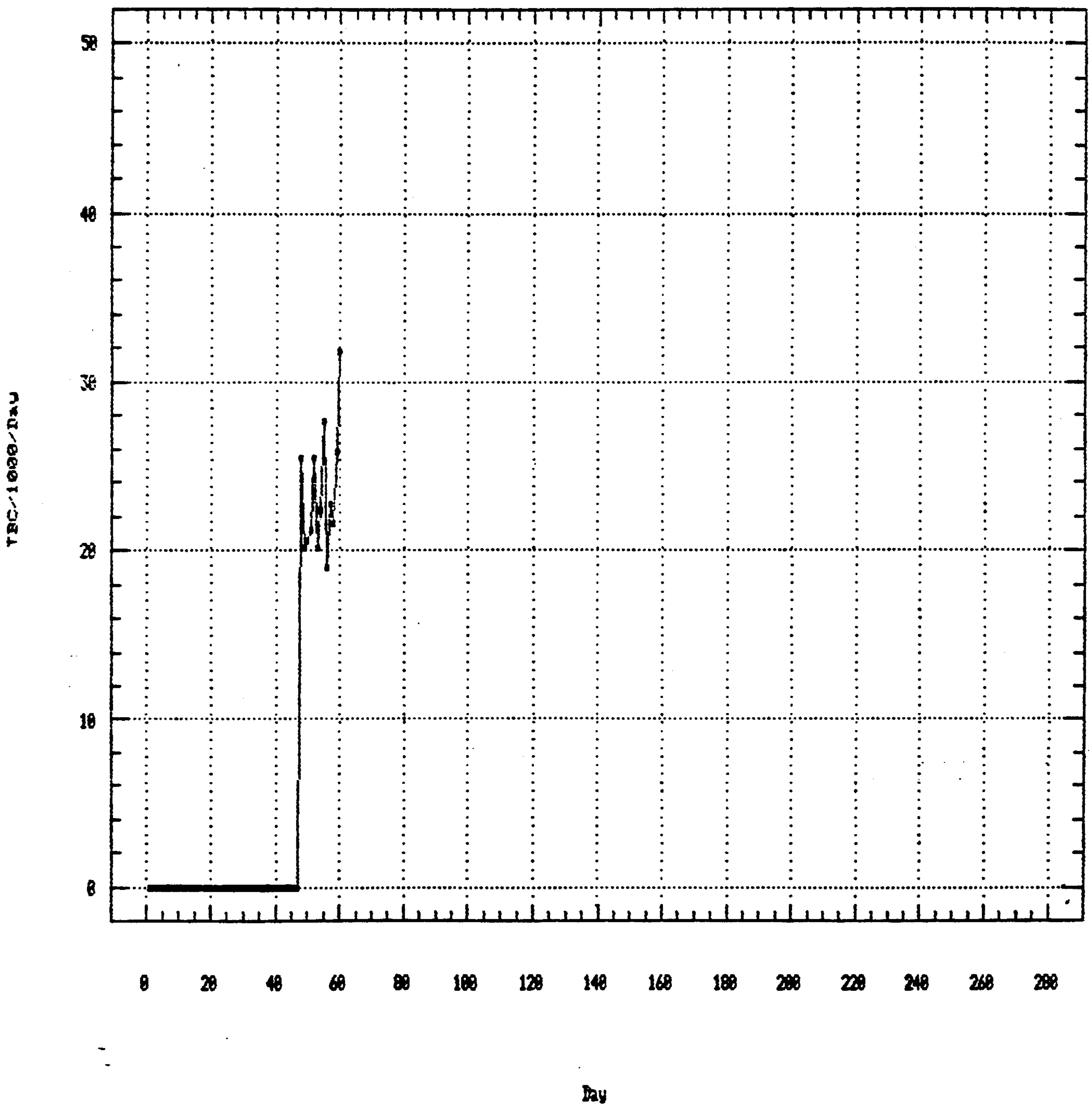
Corps 'L'

(Average Daily Division-level Rate)



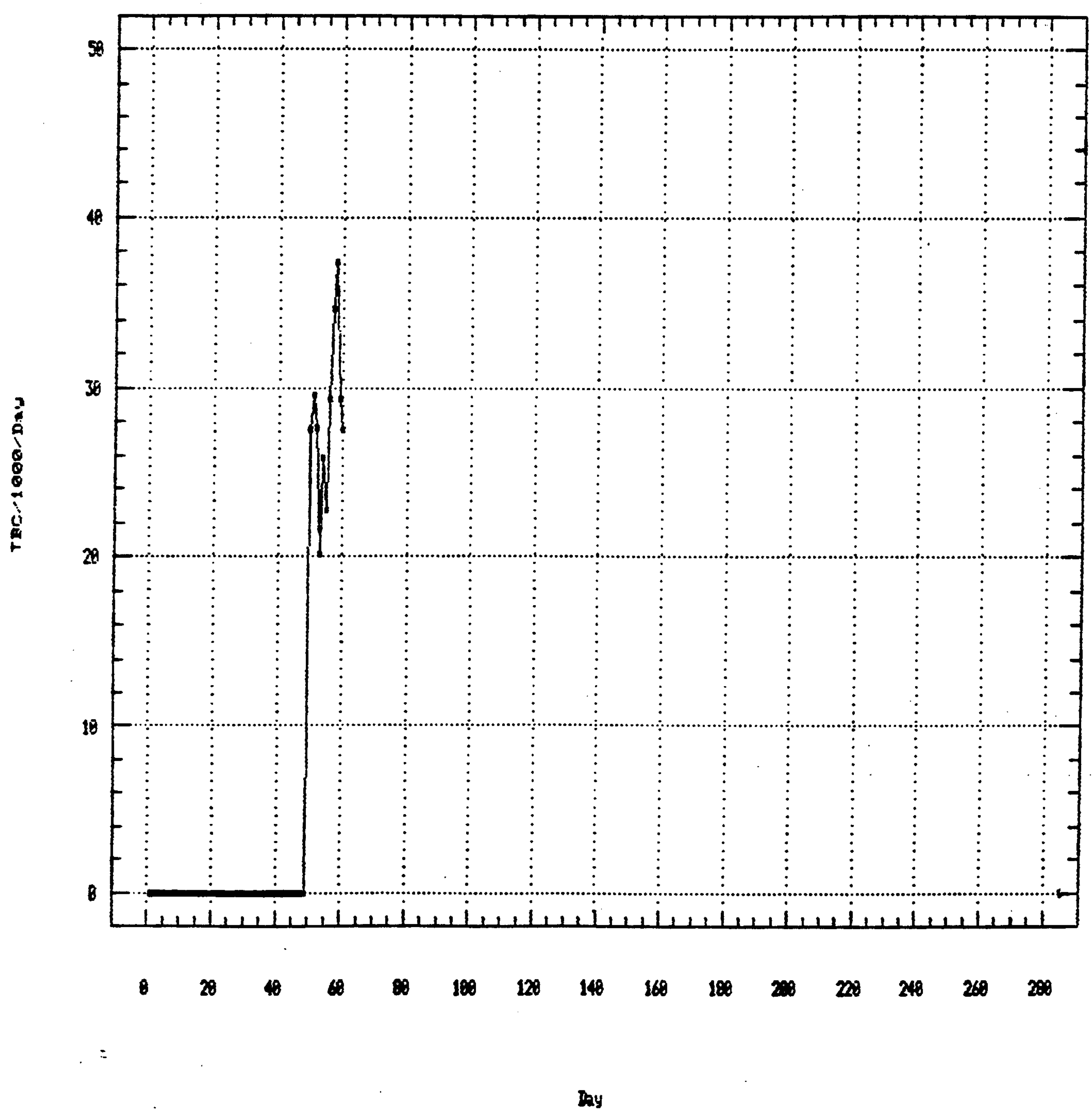
'Created Corps A'

(Average Daily Division-level Rate)



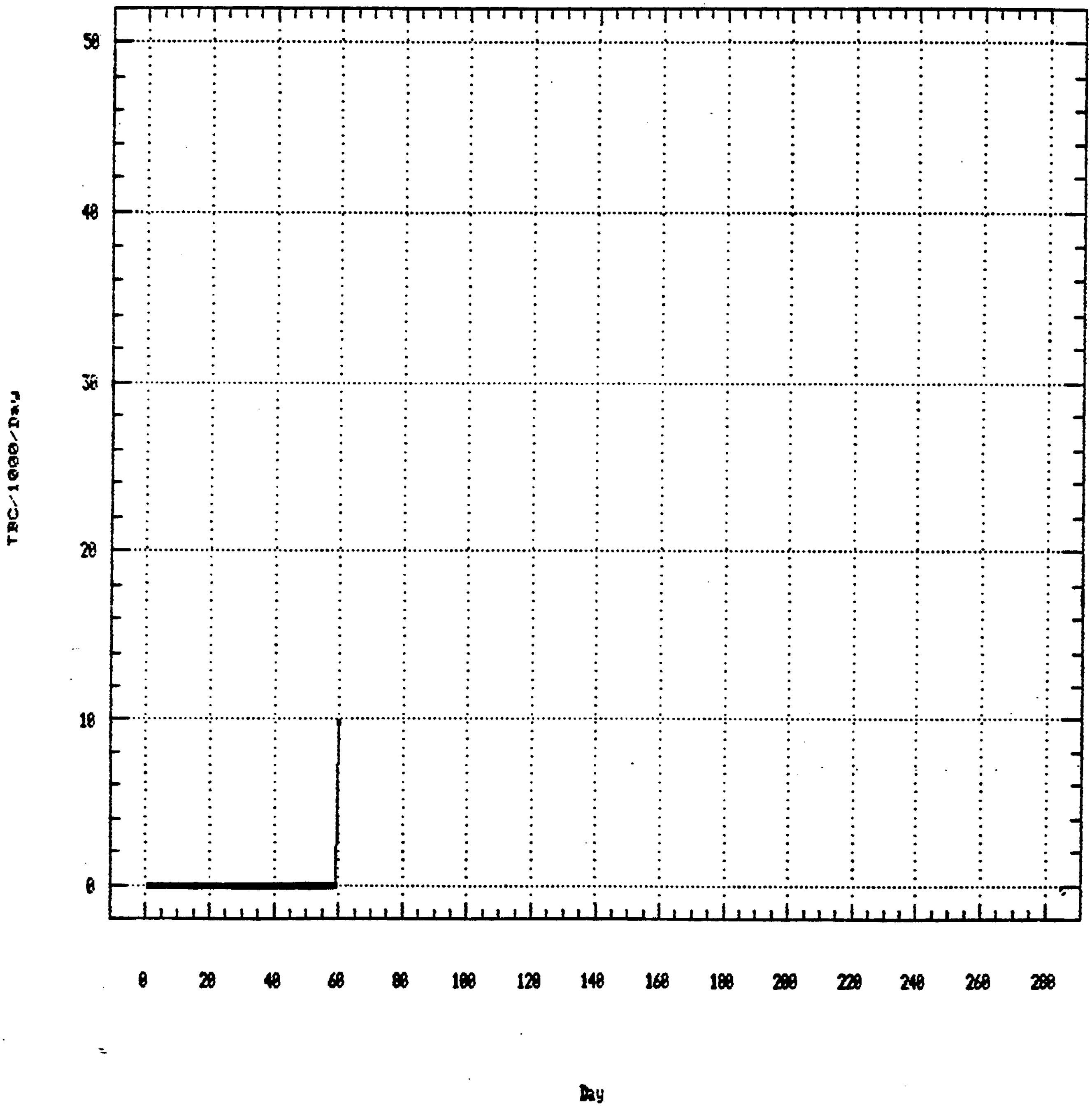
'Created Corps B'

(Average Daily Division-level Rate)



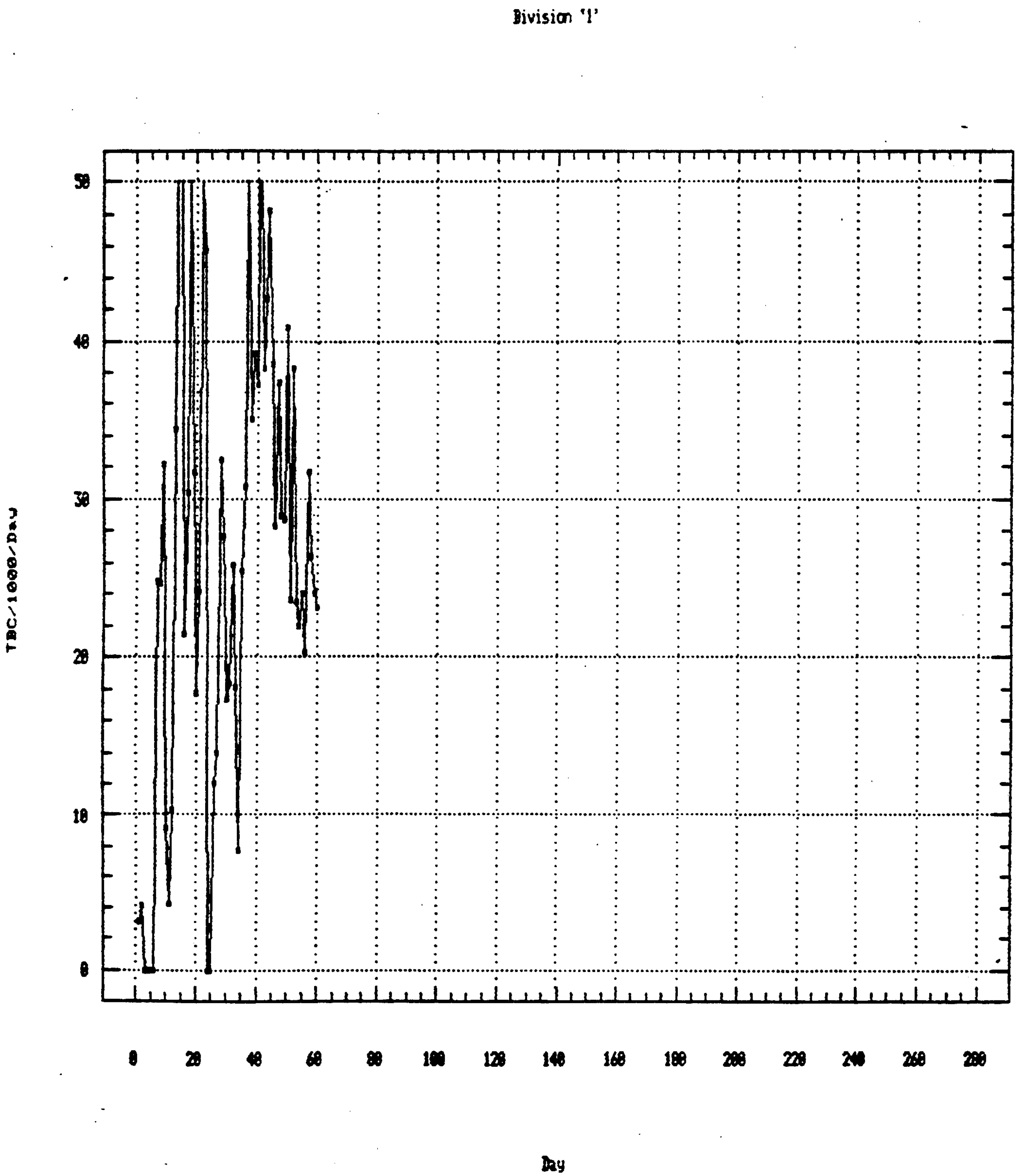
'Created Corps C'

(Average Daily Division-level Rate)



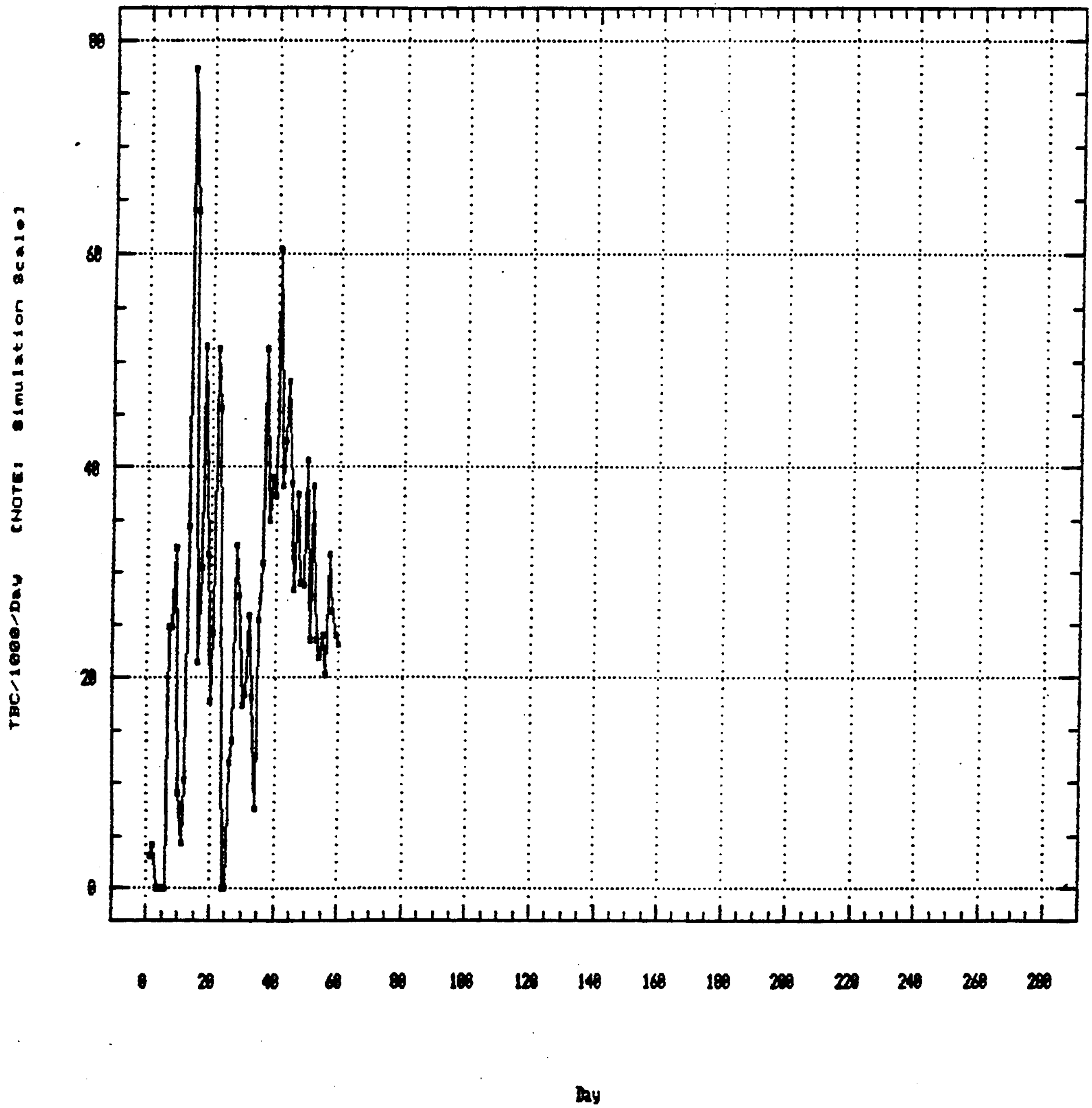
BLUE DIVISION GRAPHS

(Pages A-35 to A-120)



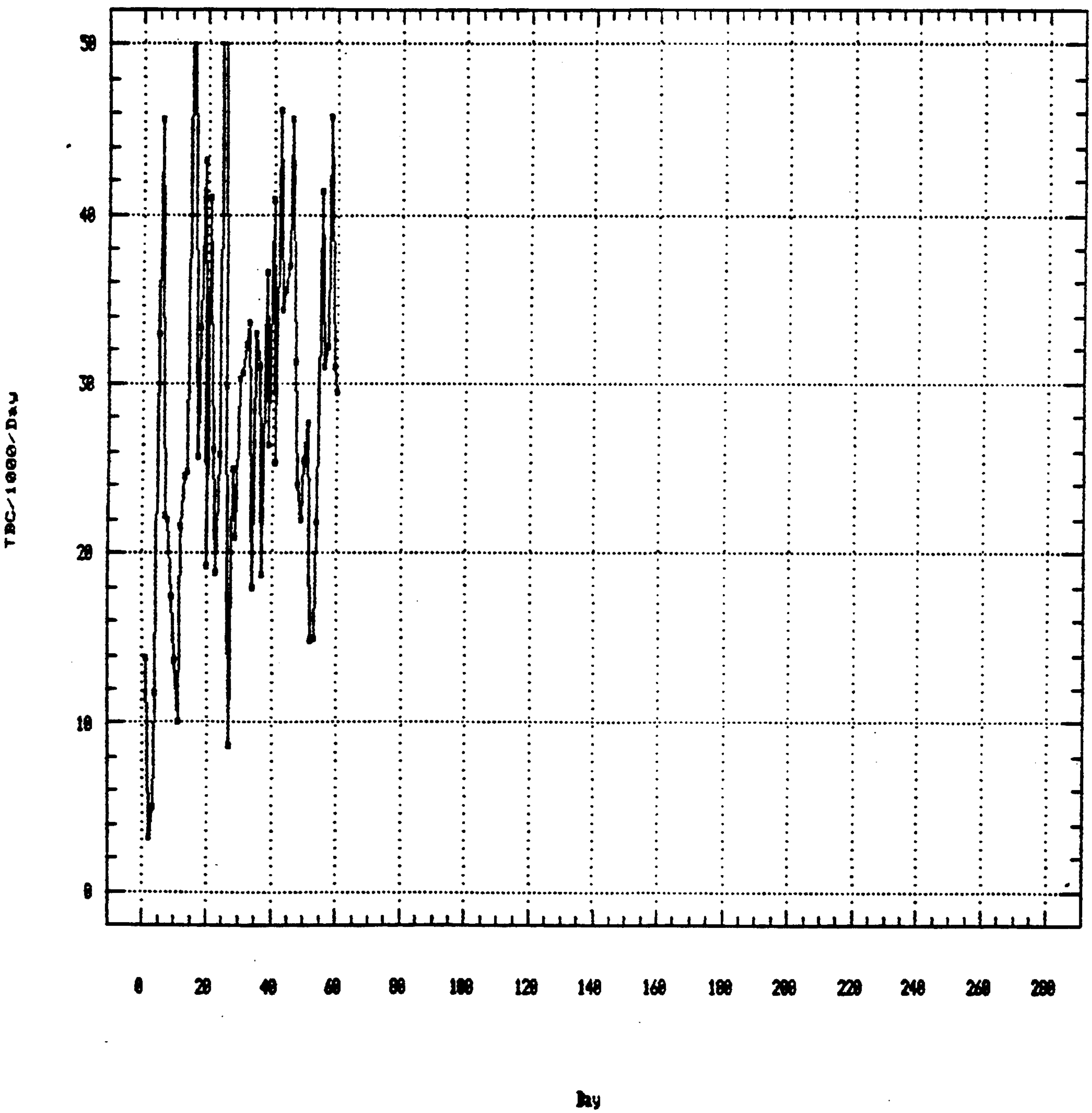
Division '1'
TBC/1000/Day
0
10
20
30
40
50
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '1'



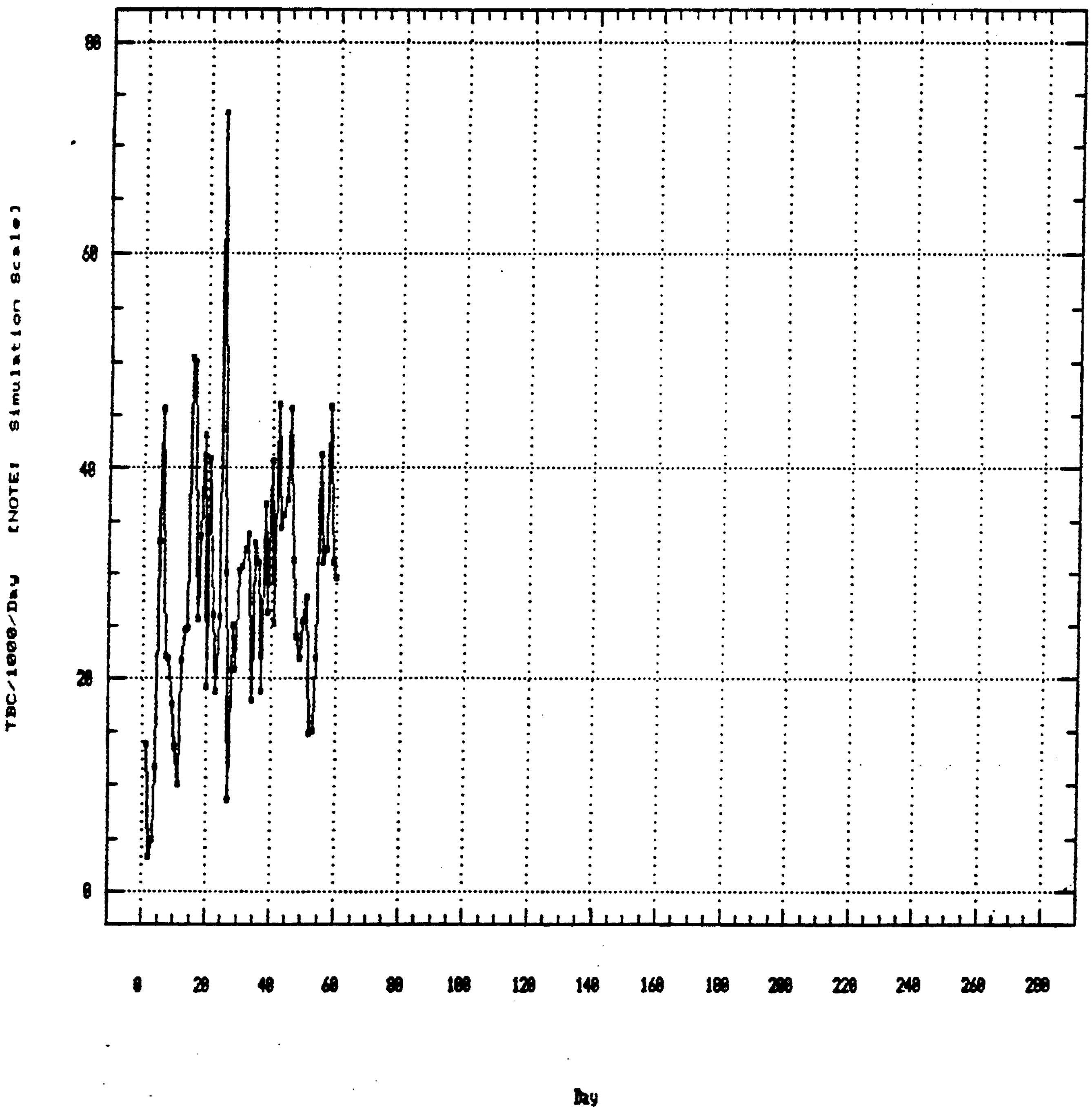
TBC/1000/Day (NOTE: Simulation Scale)
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '2'



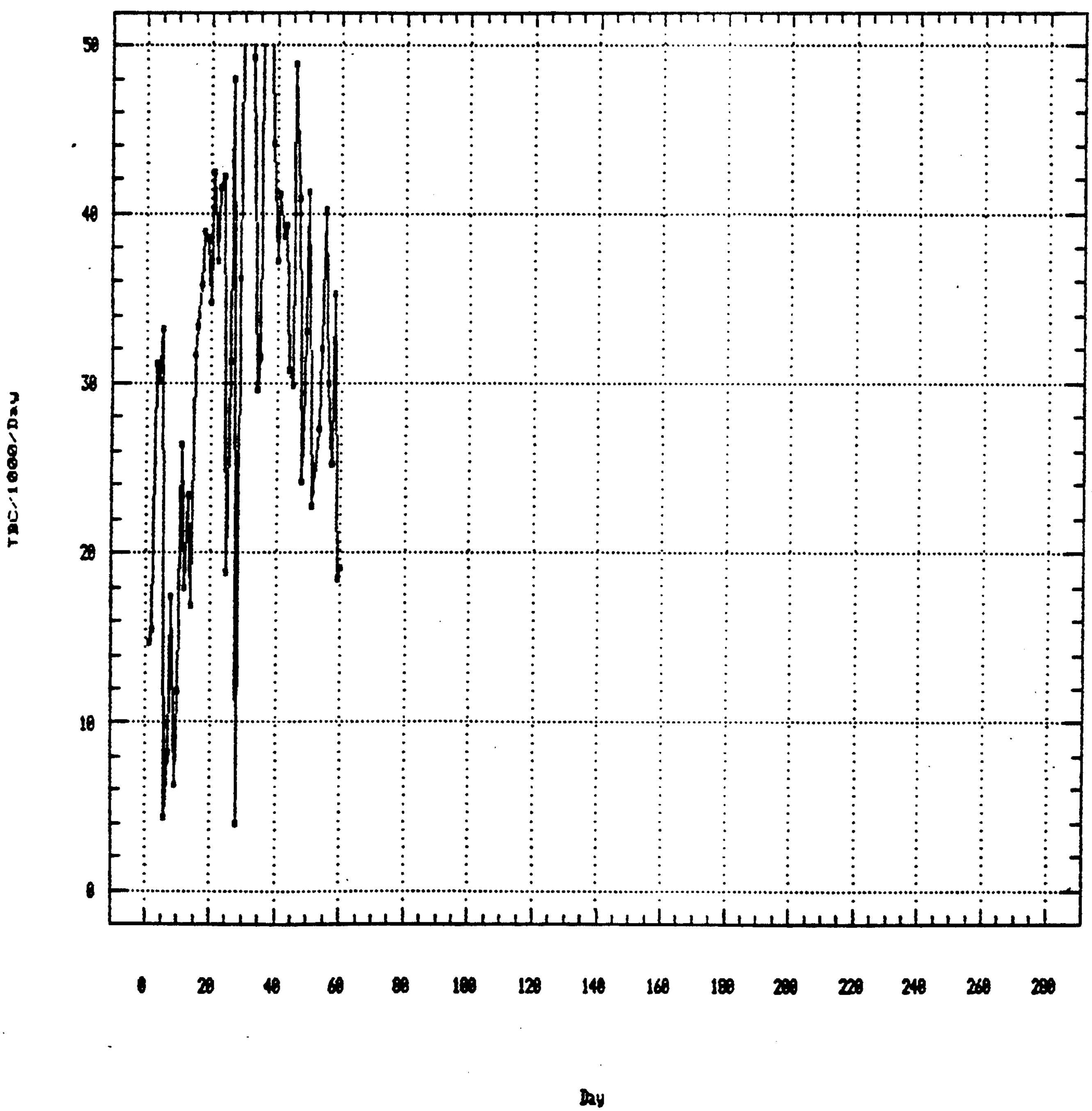
TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '2'



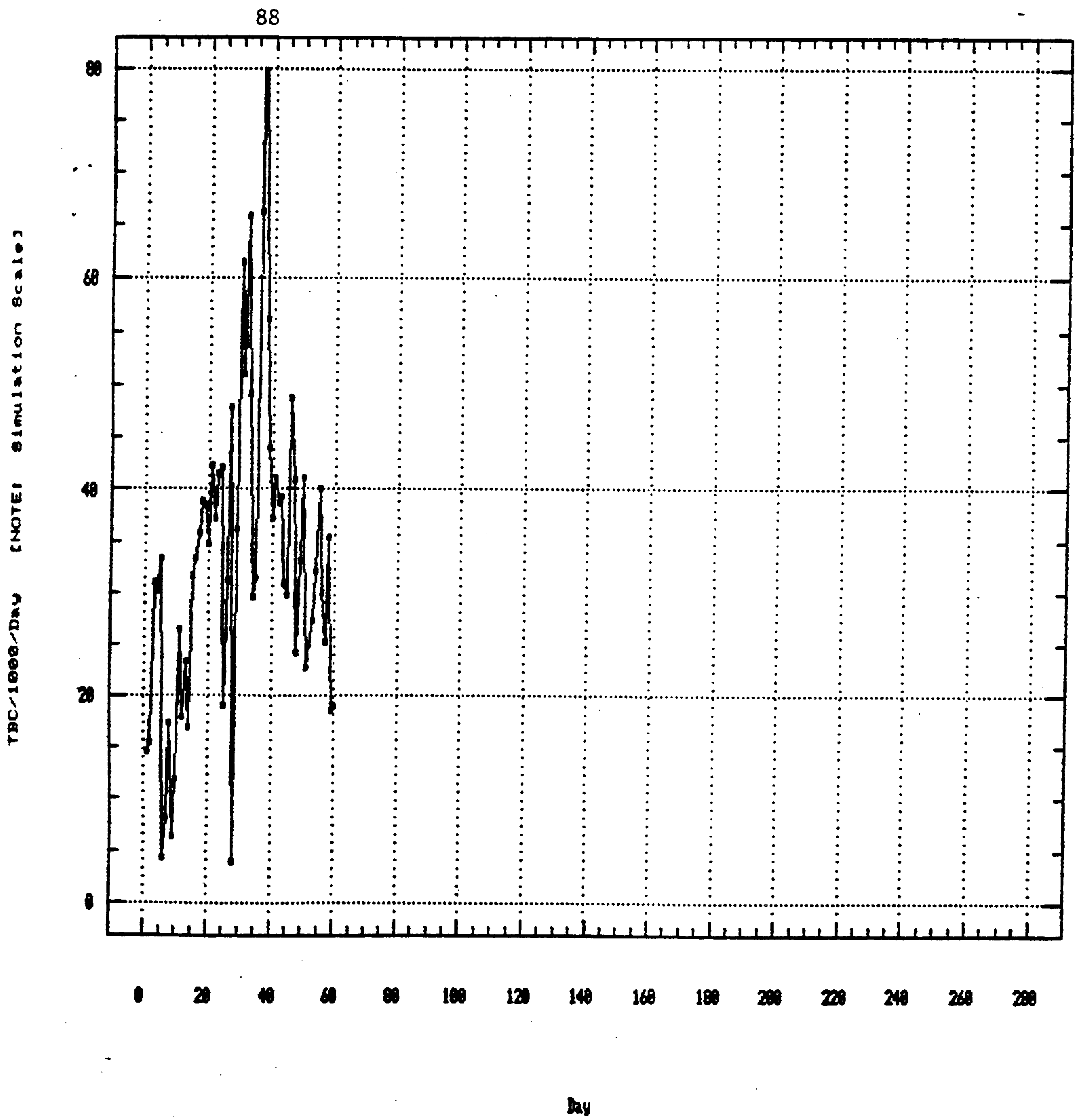
TBC/1000/Day [NOTE: Simulation Scale]
0
20
40
60
80
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '3'

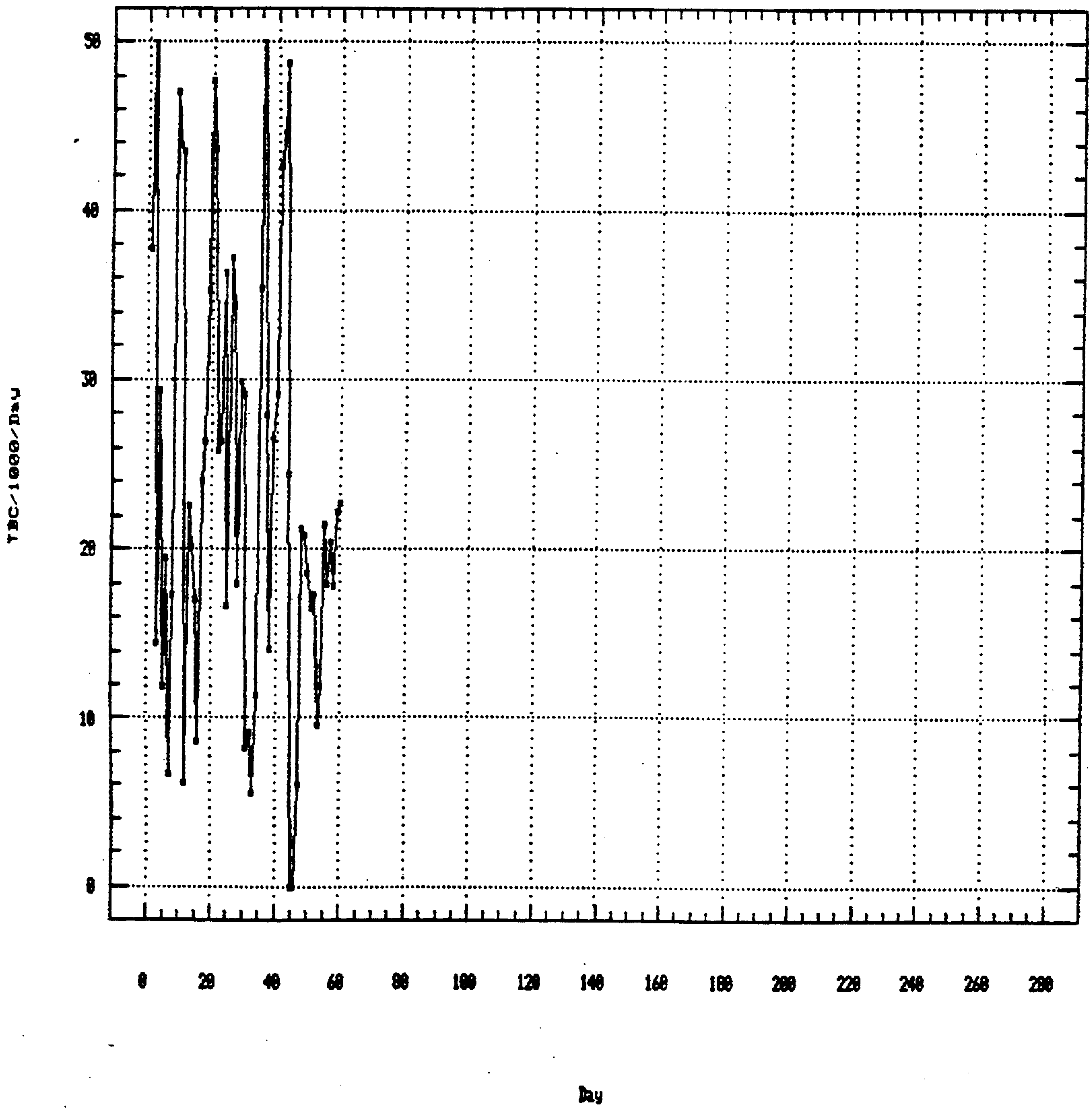


TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '3'

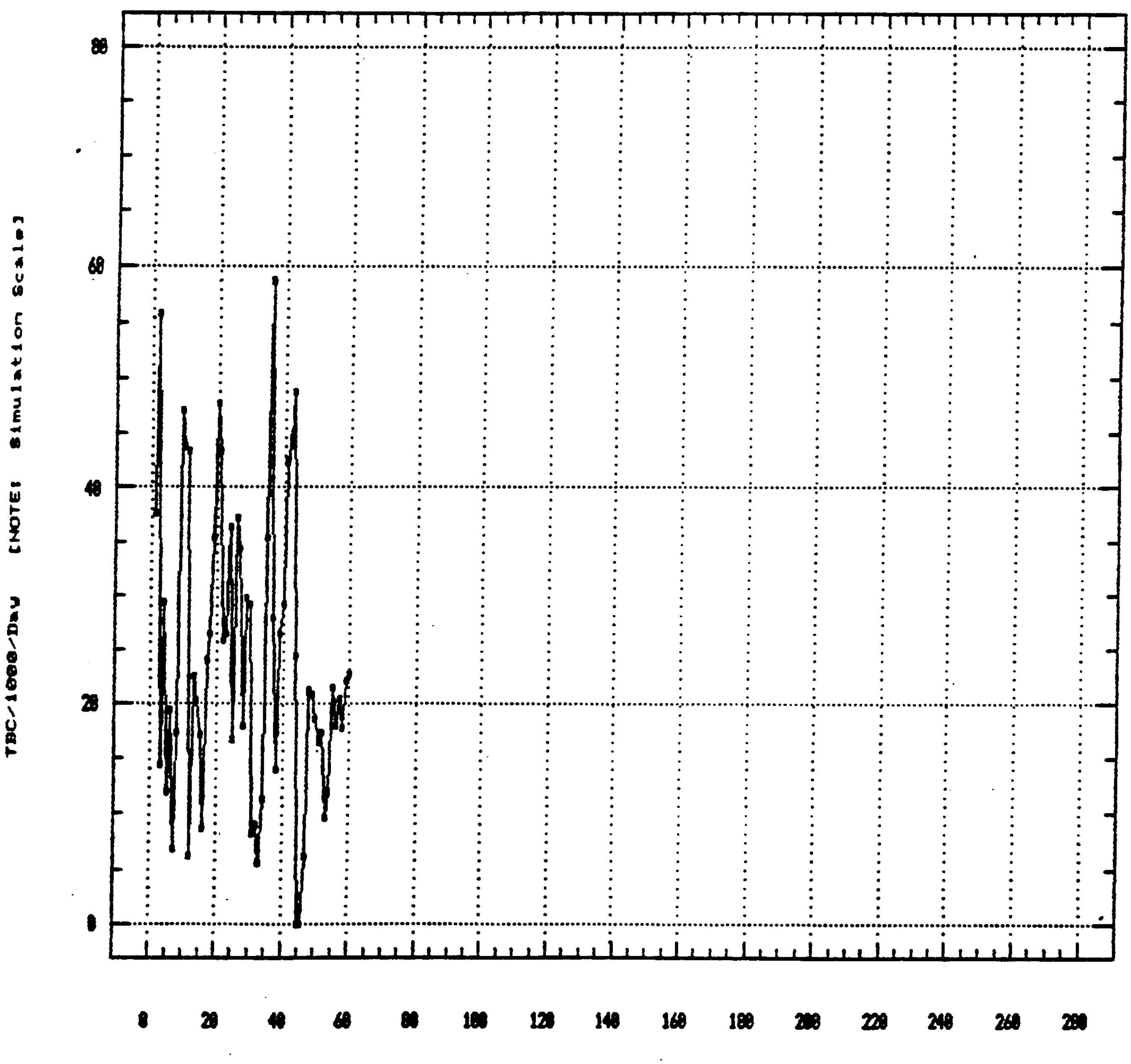

88
80
60
40
20
0
TBC/1000/Day [NOTE: Simulation Scale]
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '4'

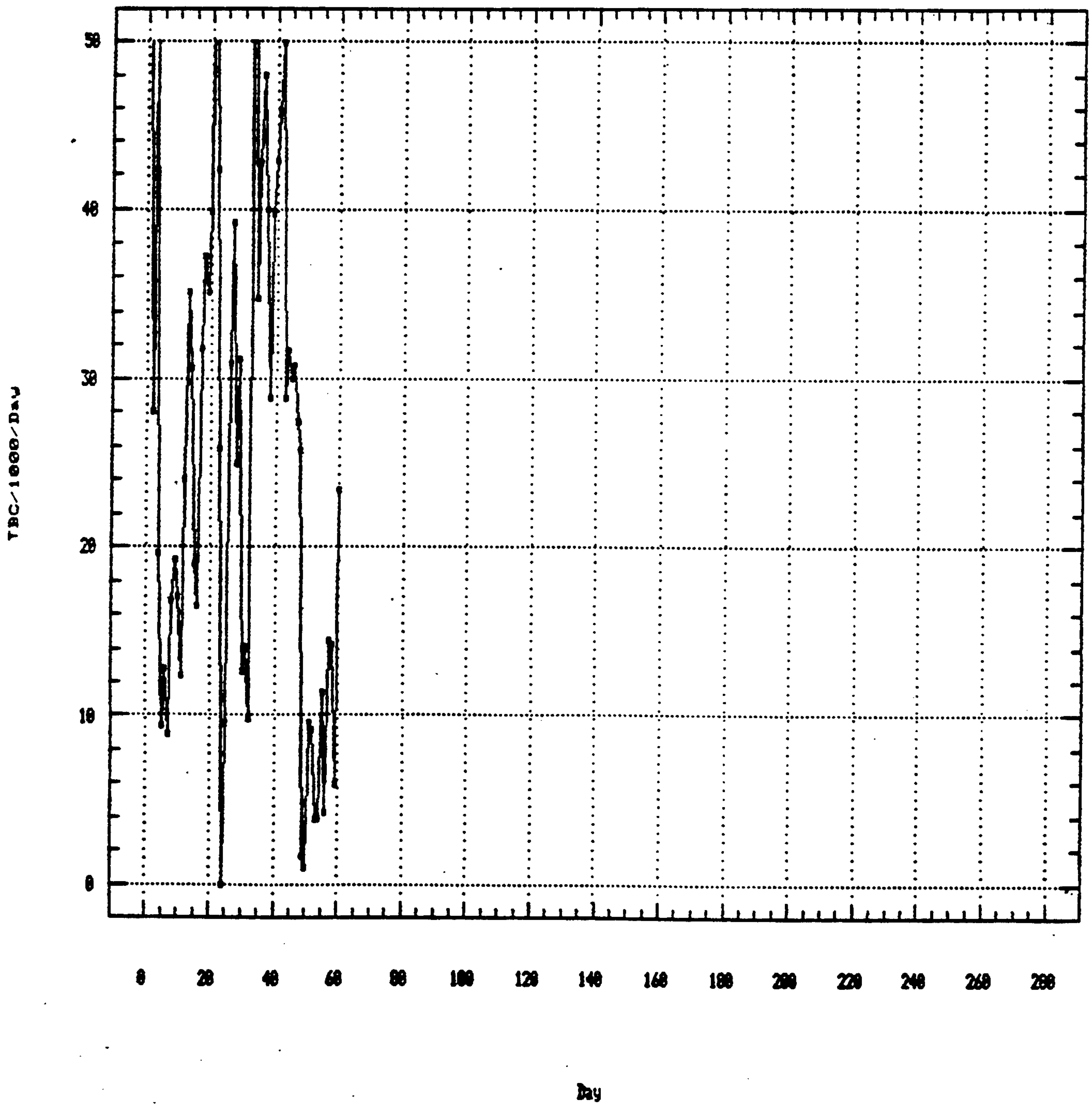


50
40
30
20
10
0
TBC/1000/Day
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '4'

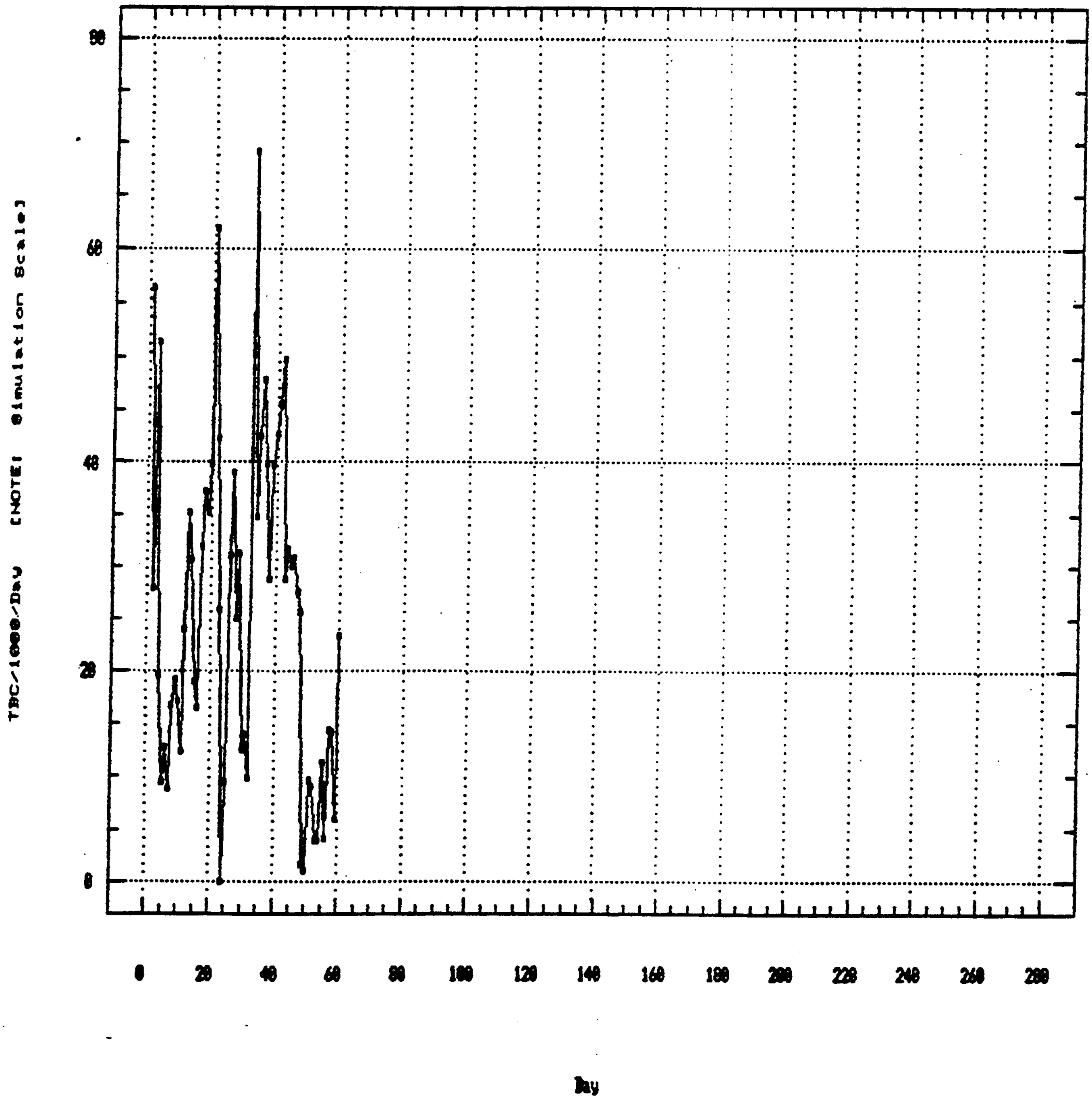

TBC/1000/Day [NOTE: Simulation Scale]
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '5'



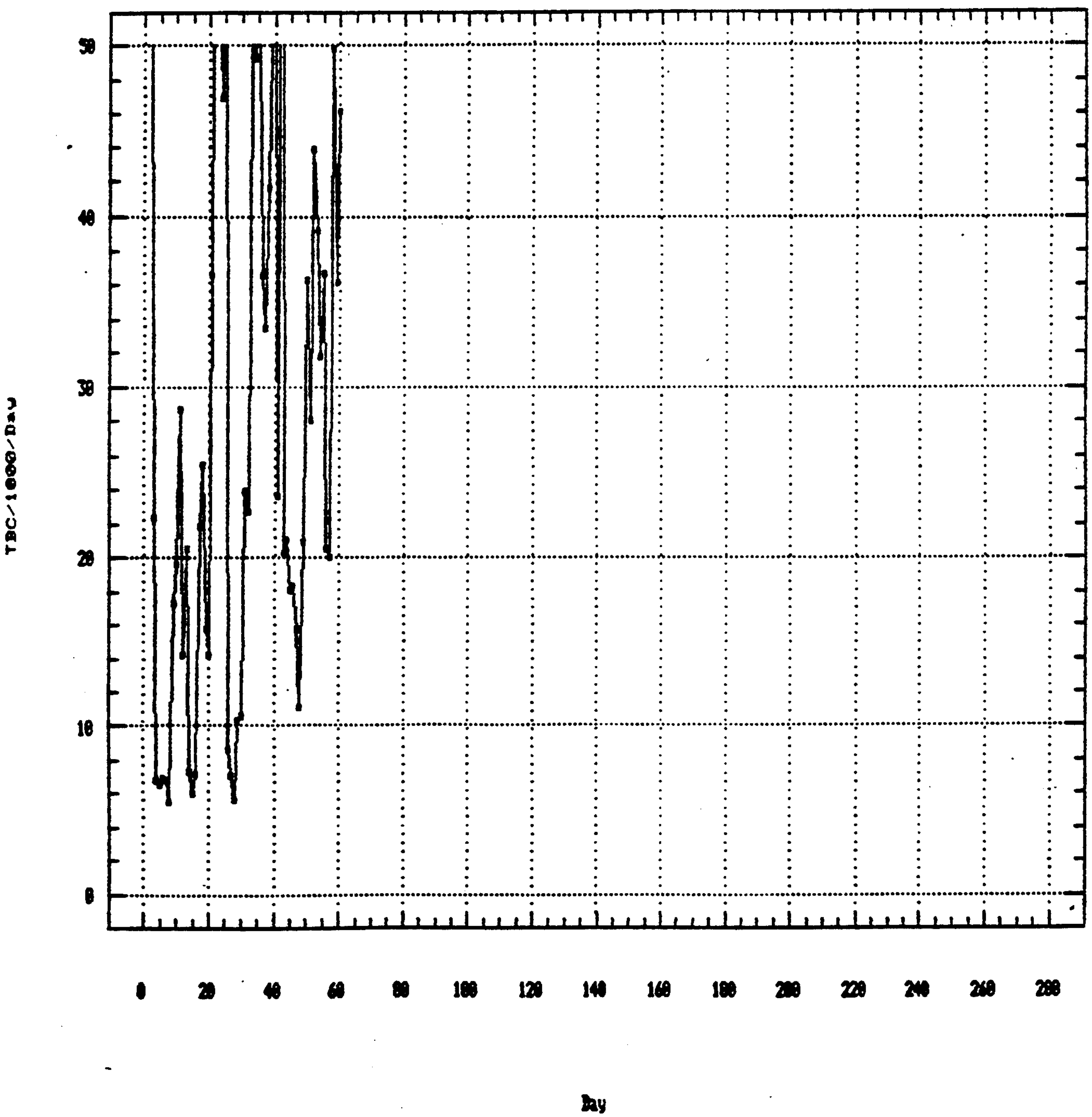
TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '5'



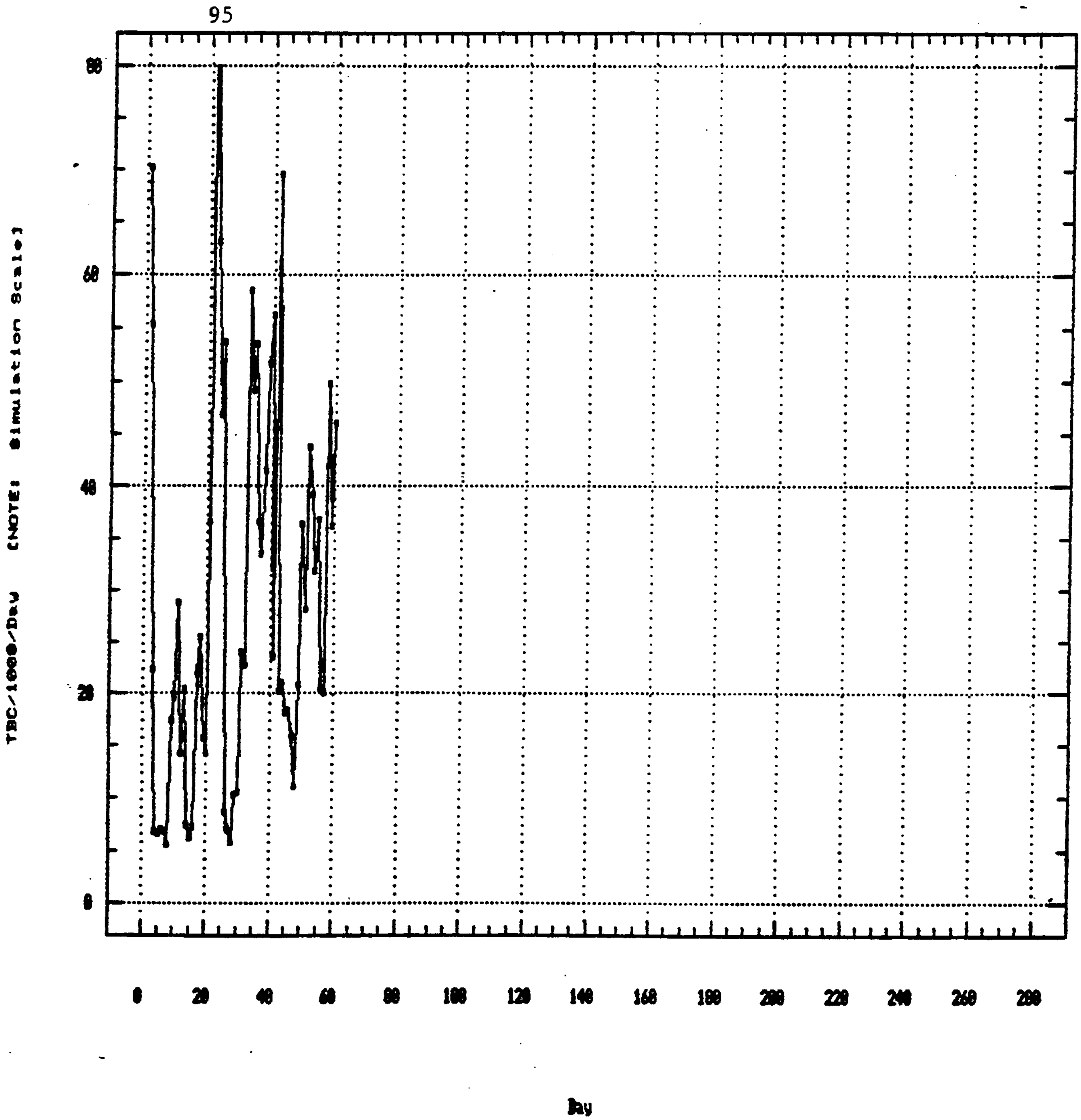
TBC/1000/Day [NOTE: Simulation Scale]
0
20
40
60
80
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '6'

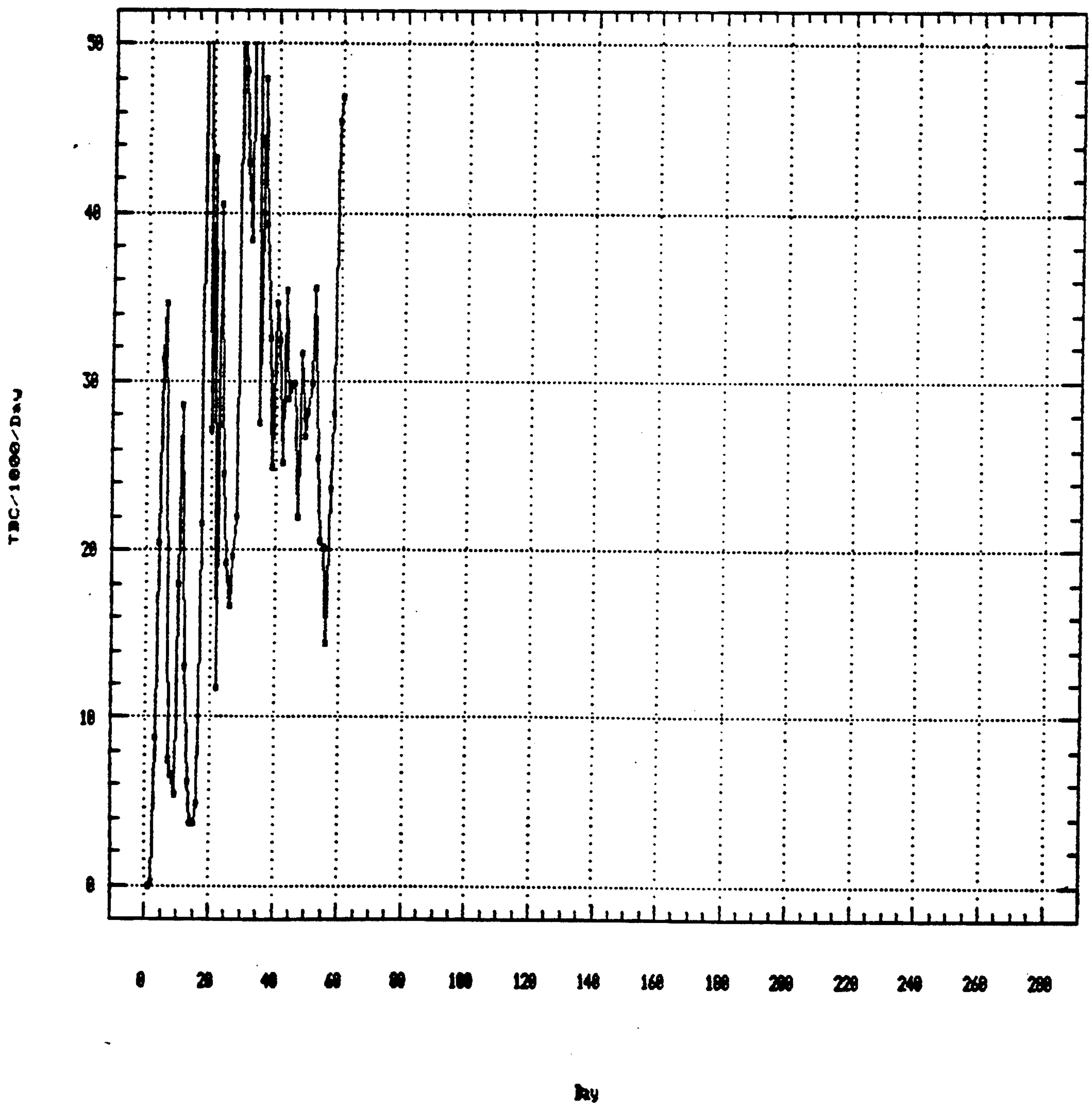


TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '6'

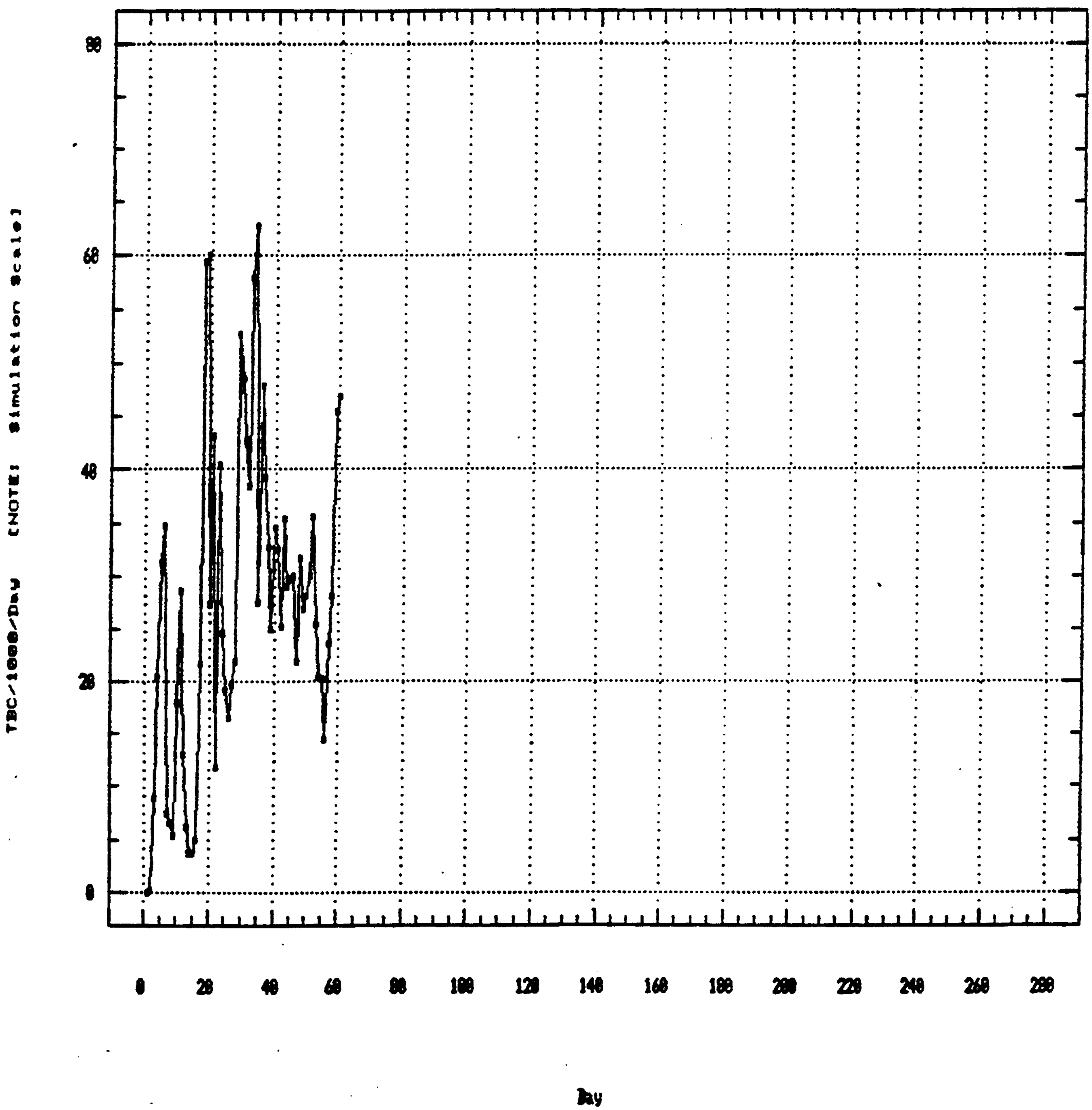

95
80
60
40
20
0
TBC/1000/Day (NOTE: Simulation Scale)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '7'



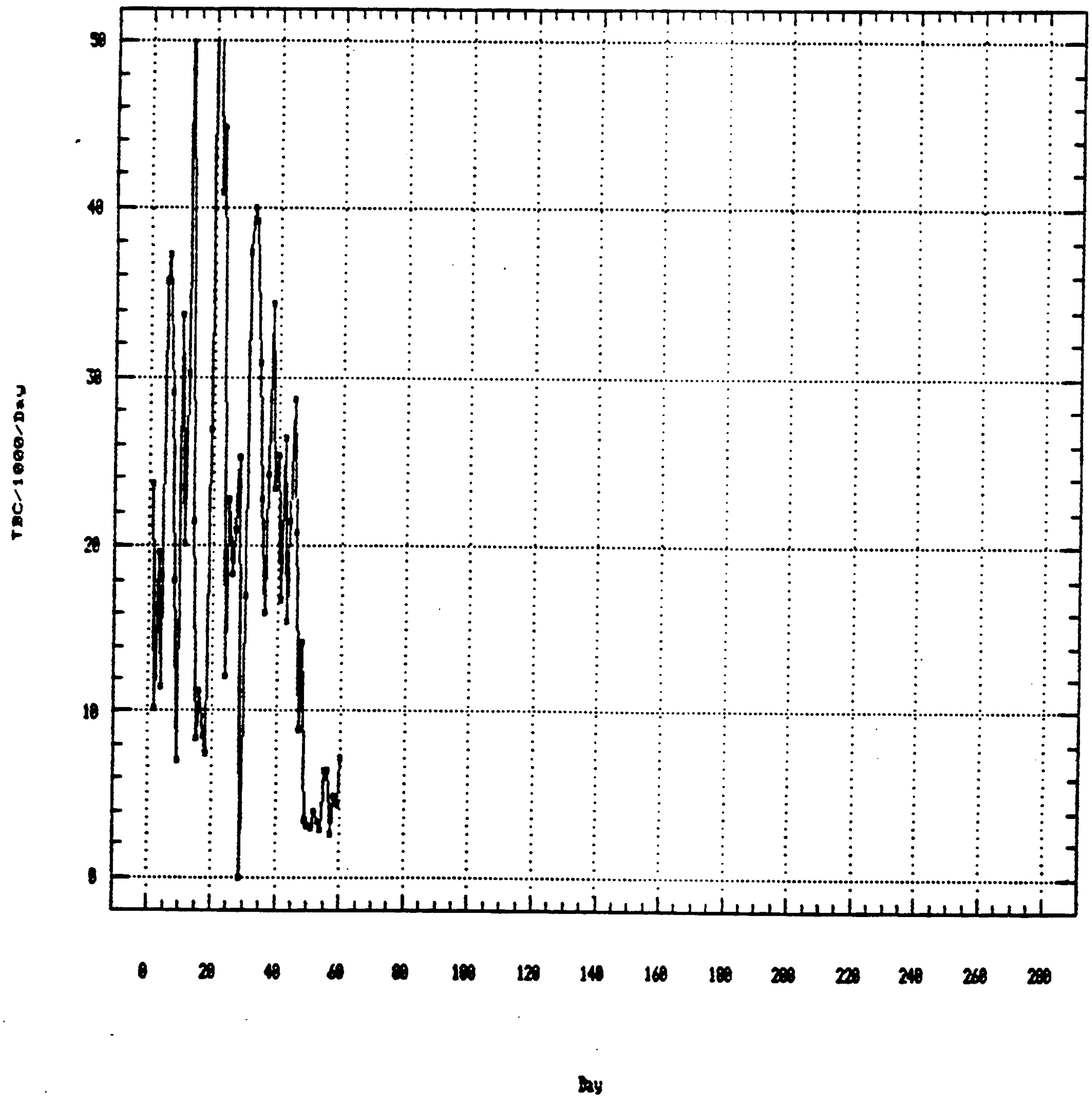
TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '7'

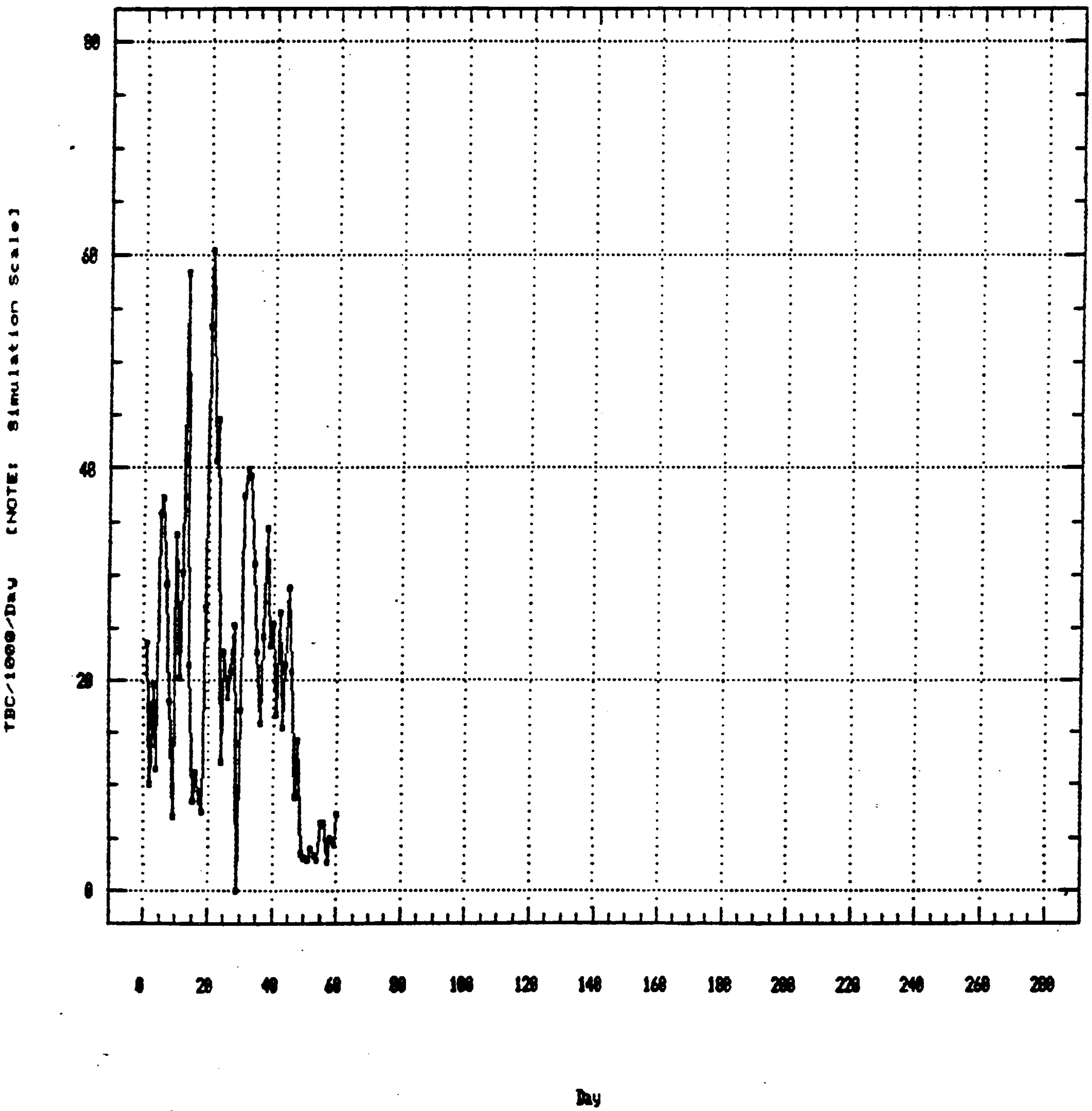


TBC/1000/Day [NOTE: Simulation Scale]
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '8'

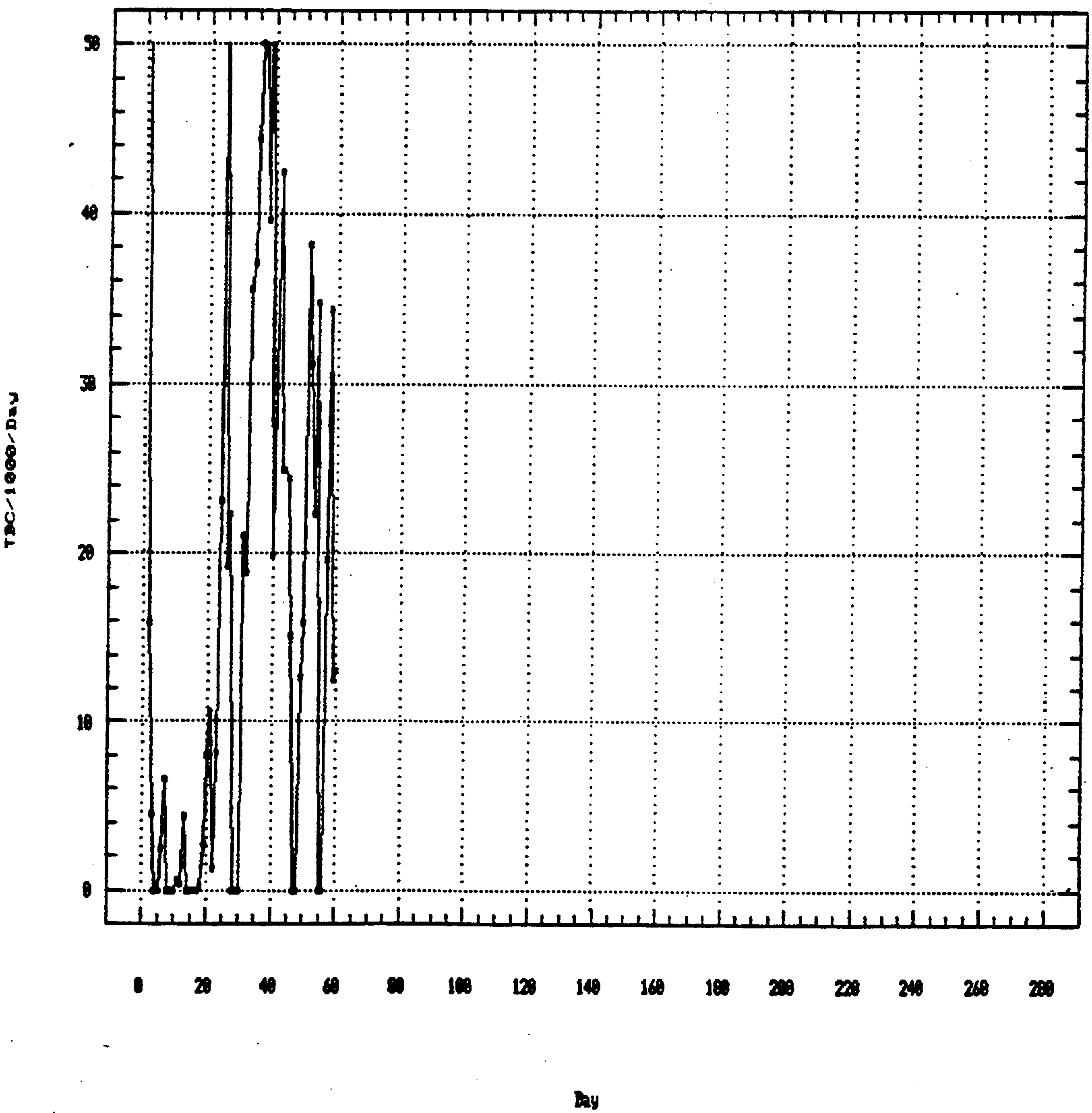

TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '8'



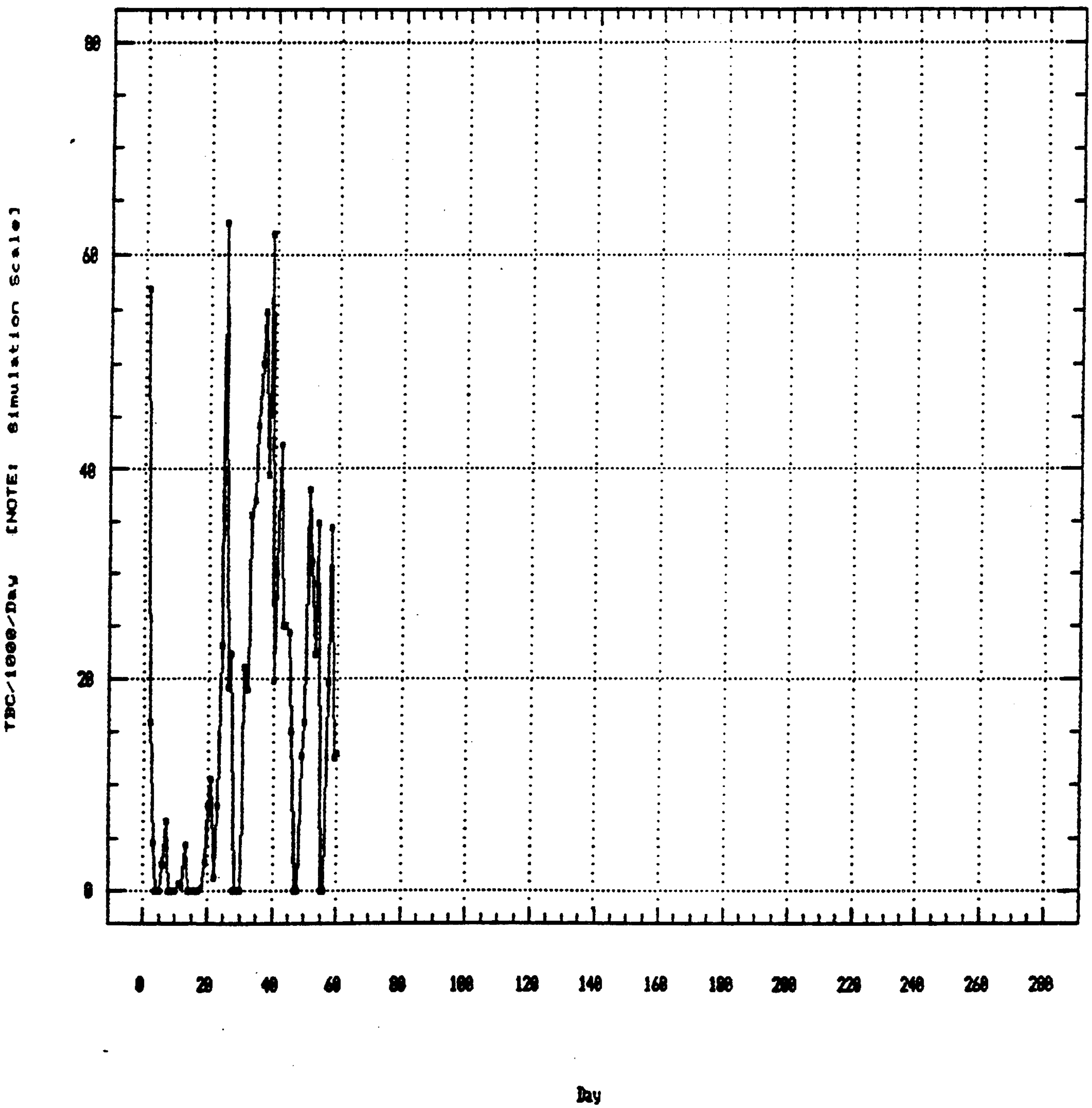
TBC/1000/Day [NOTE: Simulation Scale]
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '9'



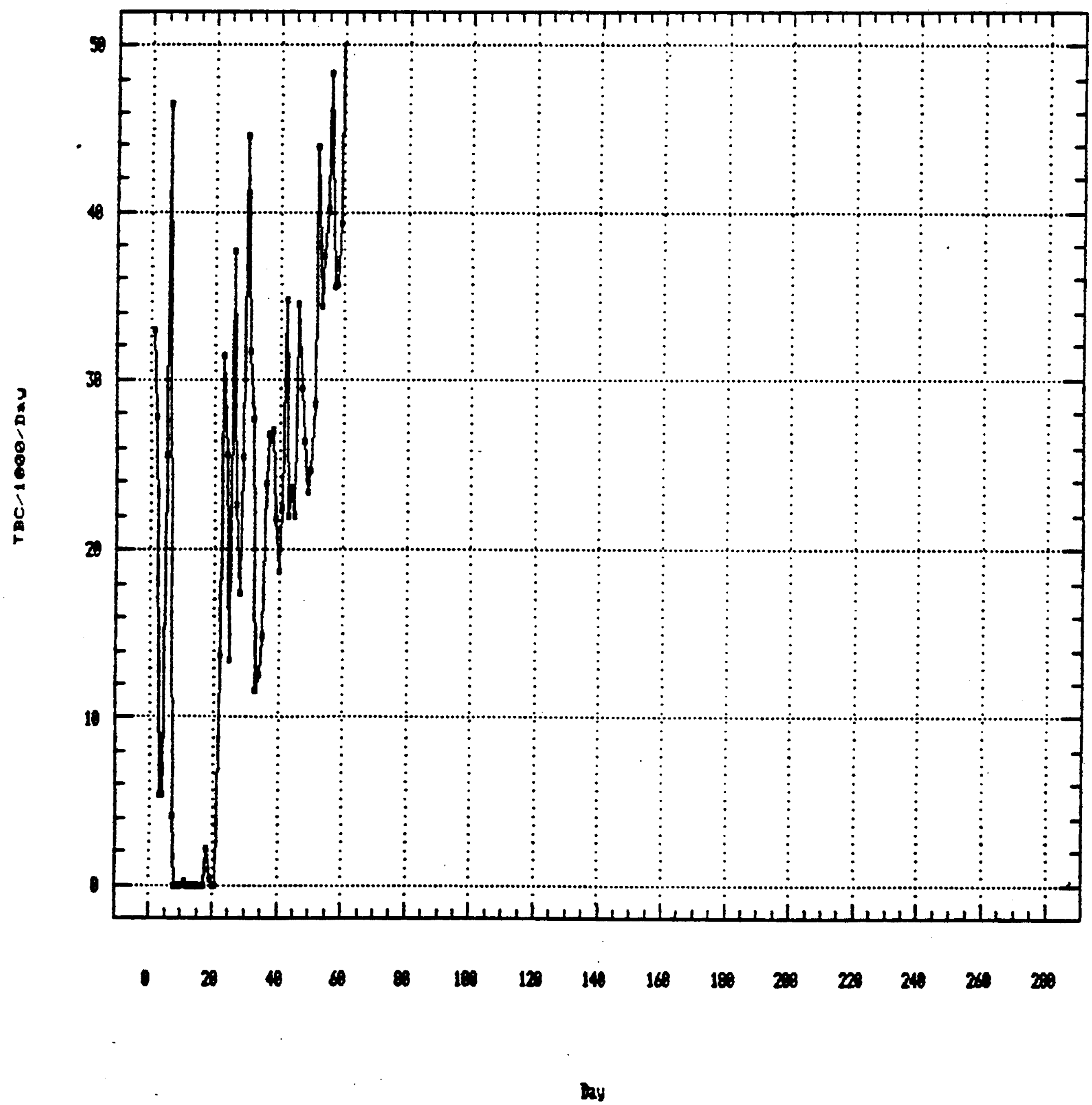
TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '9'



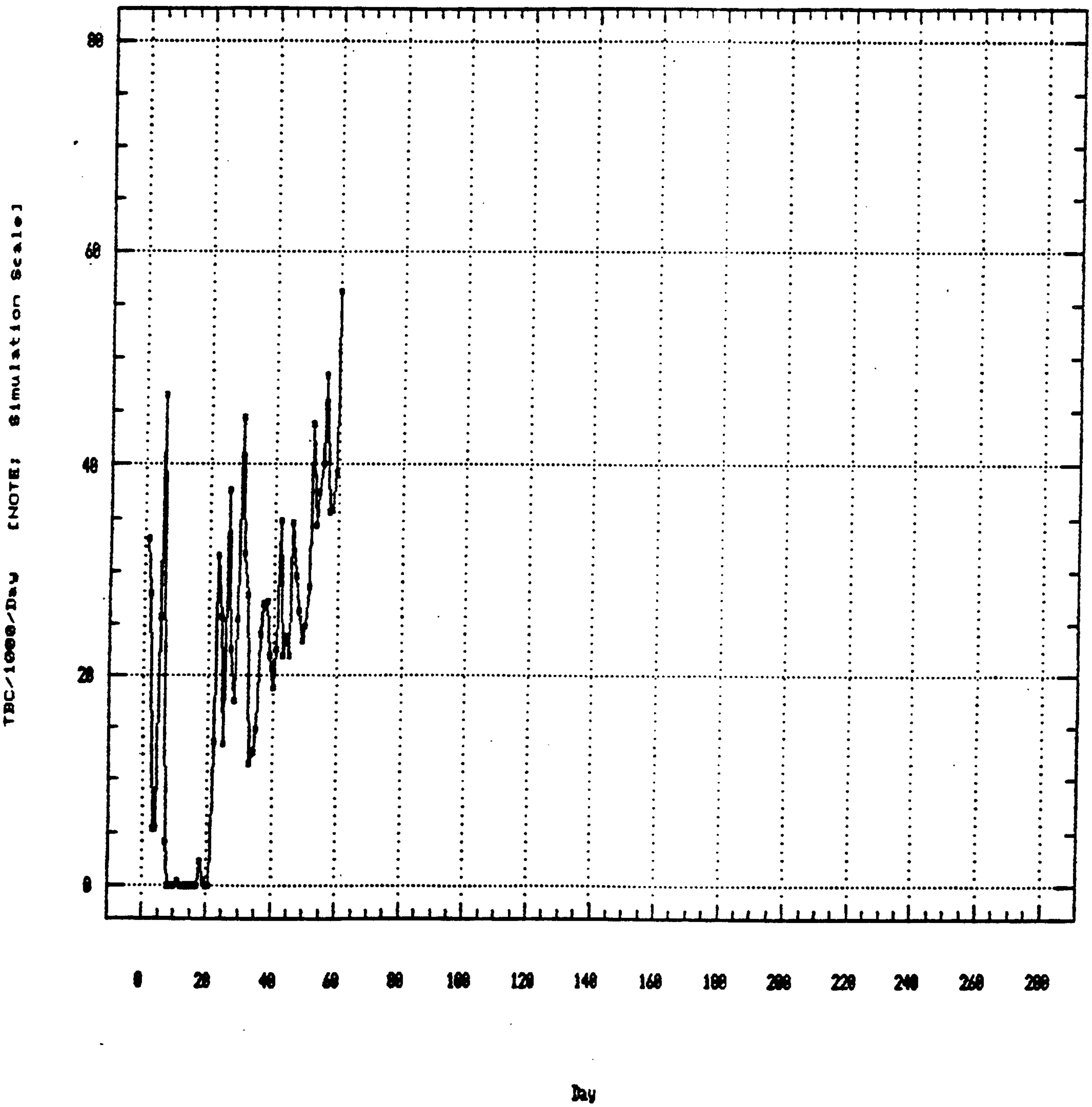
TBC/1000/Day [NOTE: Simulation Scale]
0
20
40
60
80
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '10'

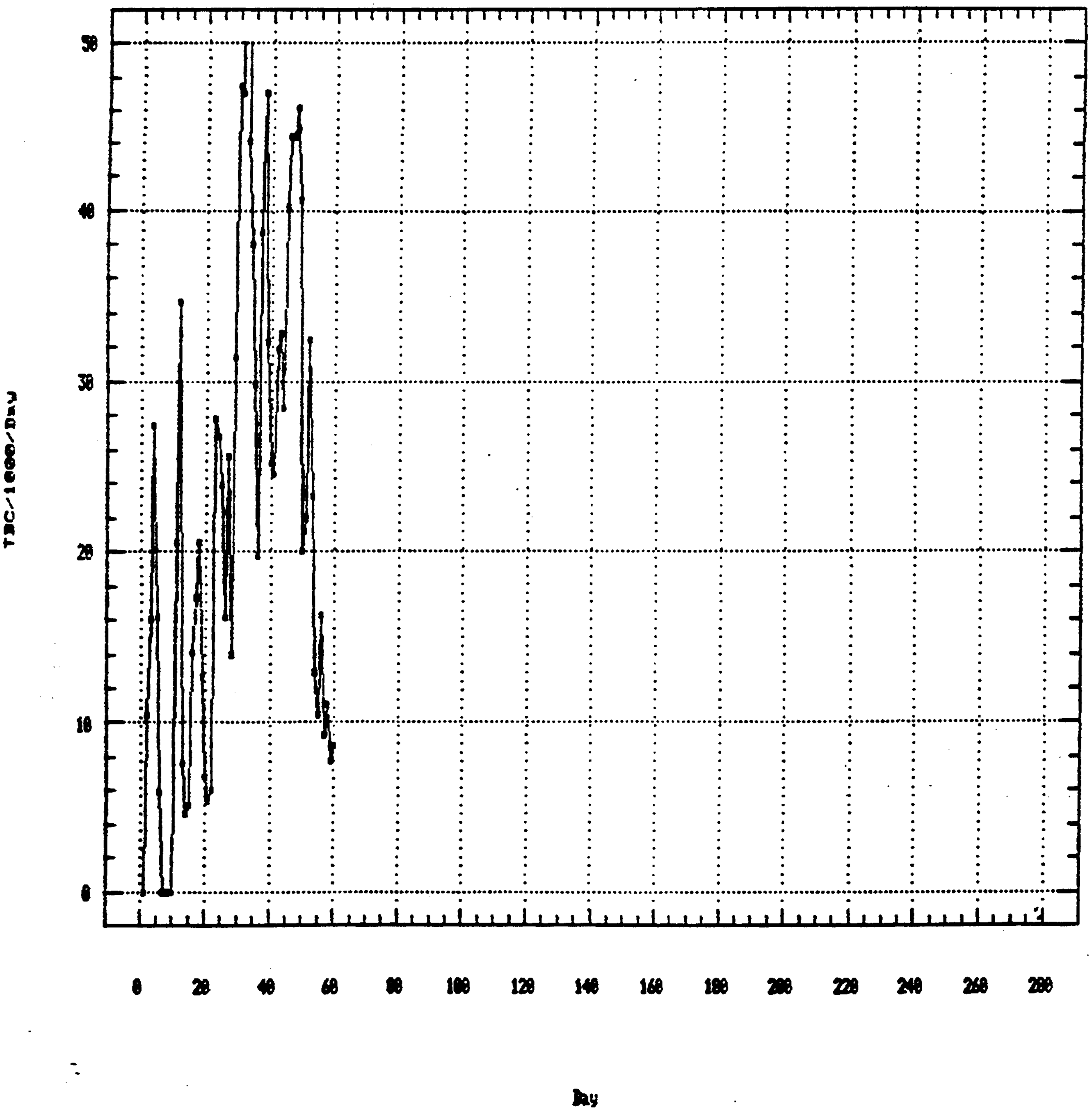


0
10
20
30
40
50
TBC/1000/Day
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '10'

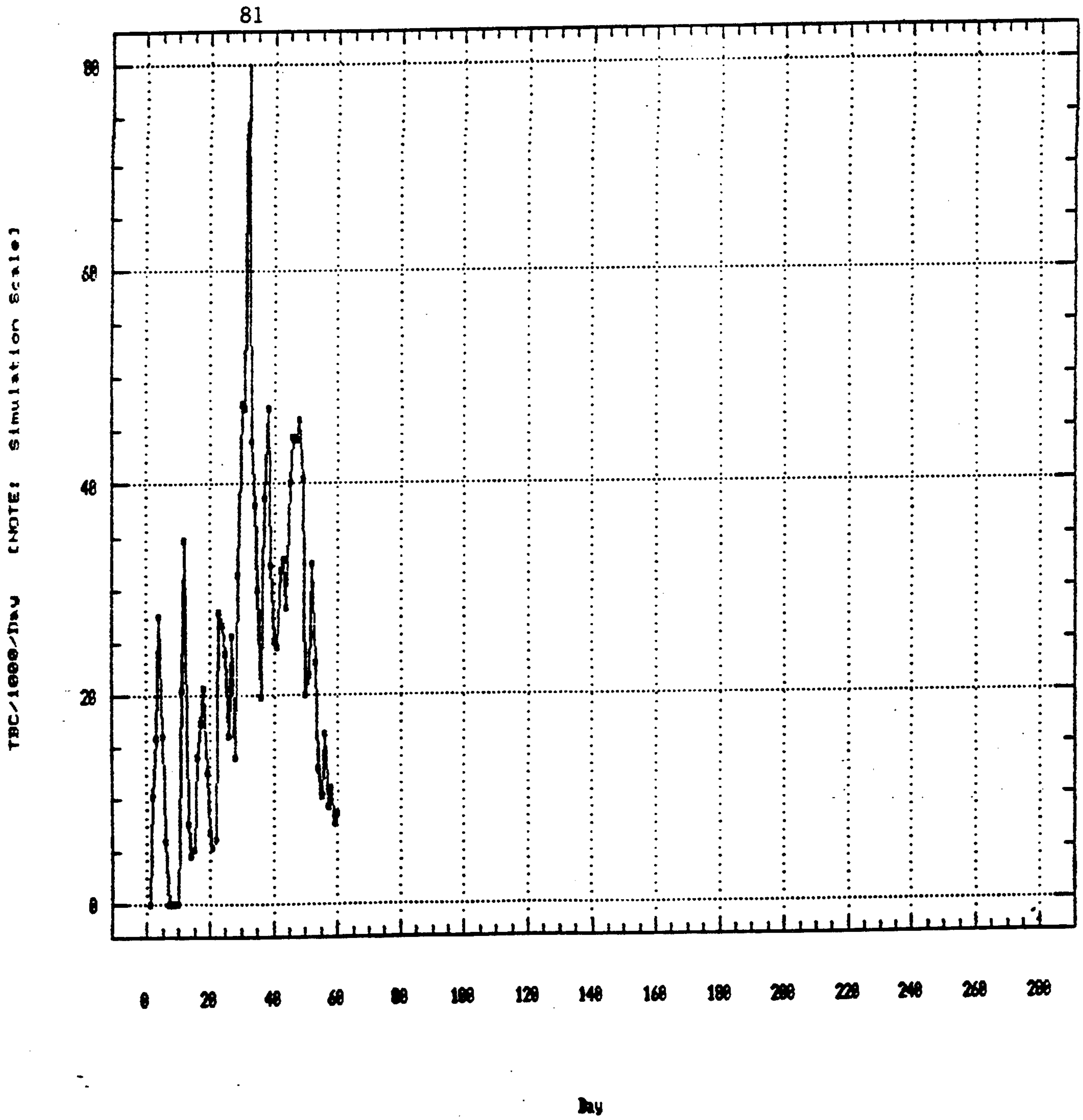

TBC/1000/Day [NOTE; Simulation Scale]
0
20
40
60
80
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280
Day

Division '11'



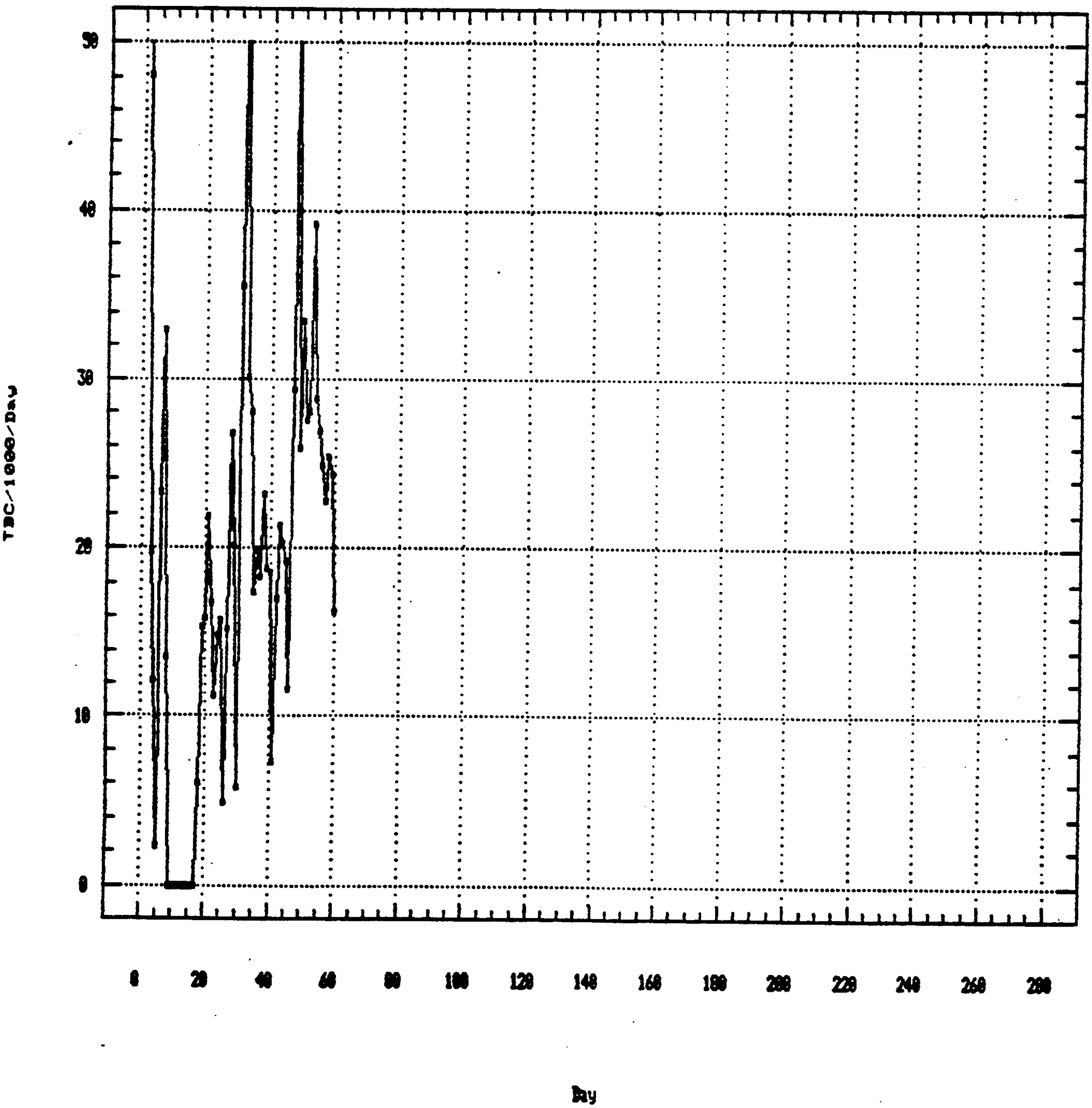
TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '11'



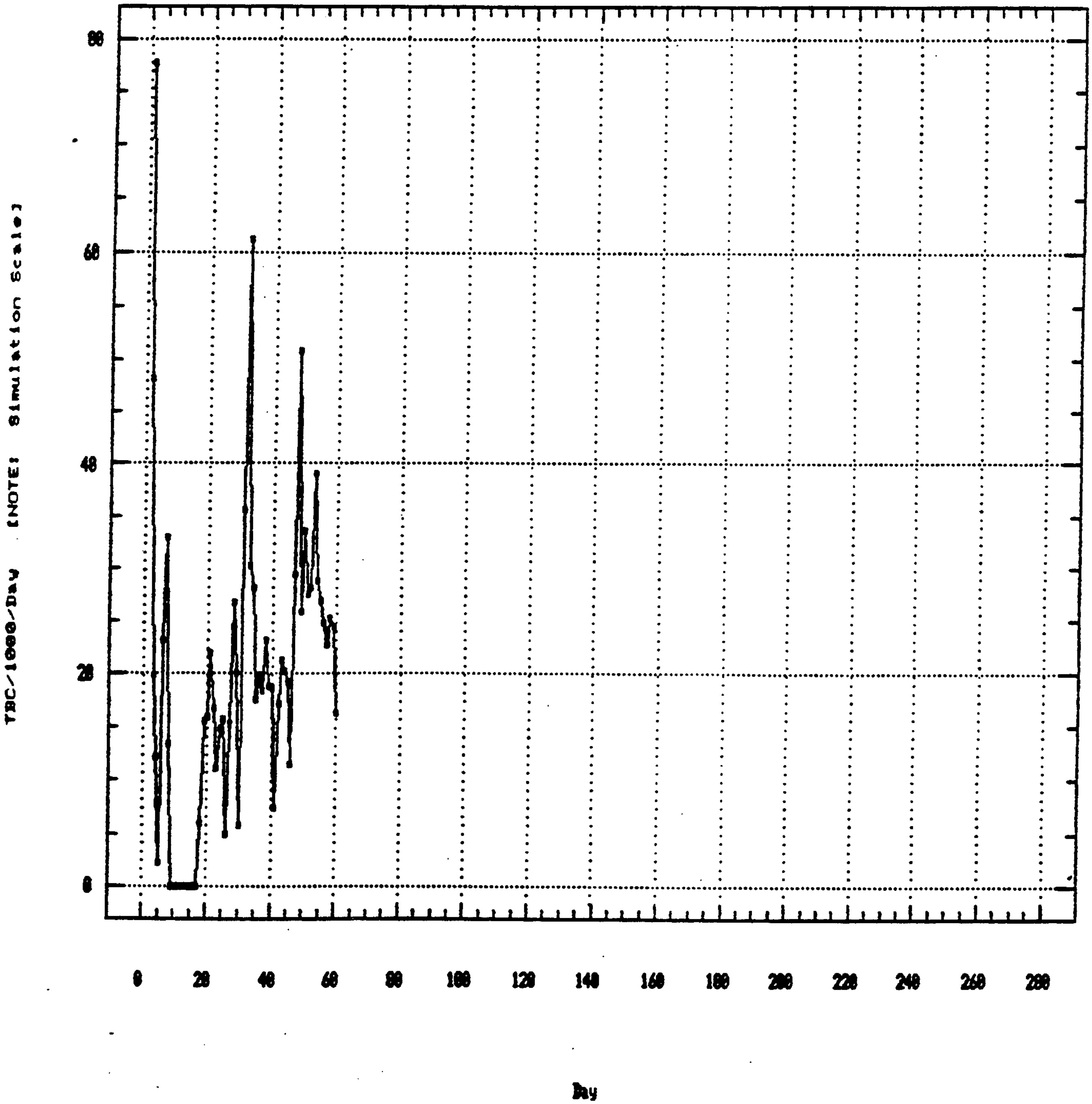
81
80
60
40
20
0
TBC/1000/Day (NOTE: Simulation Scale)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '12'



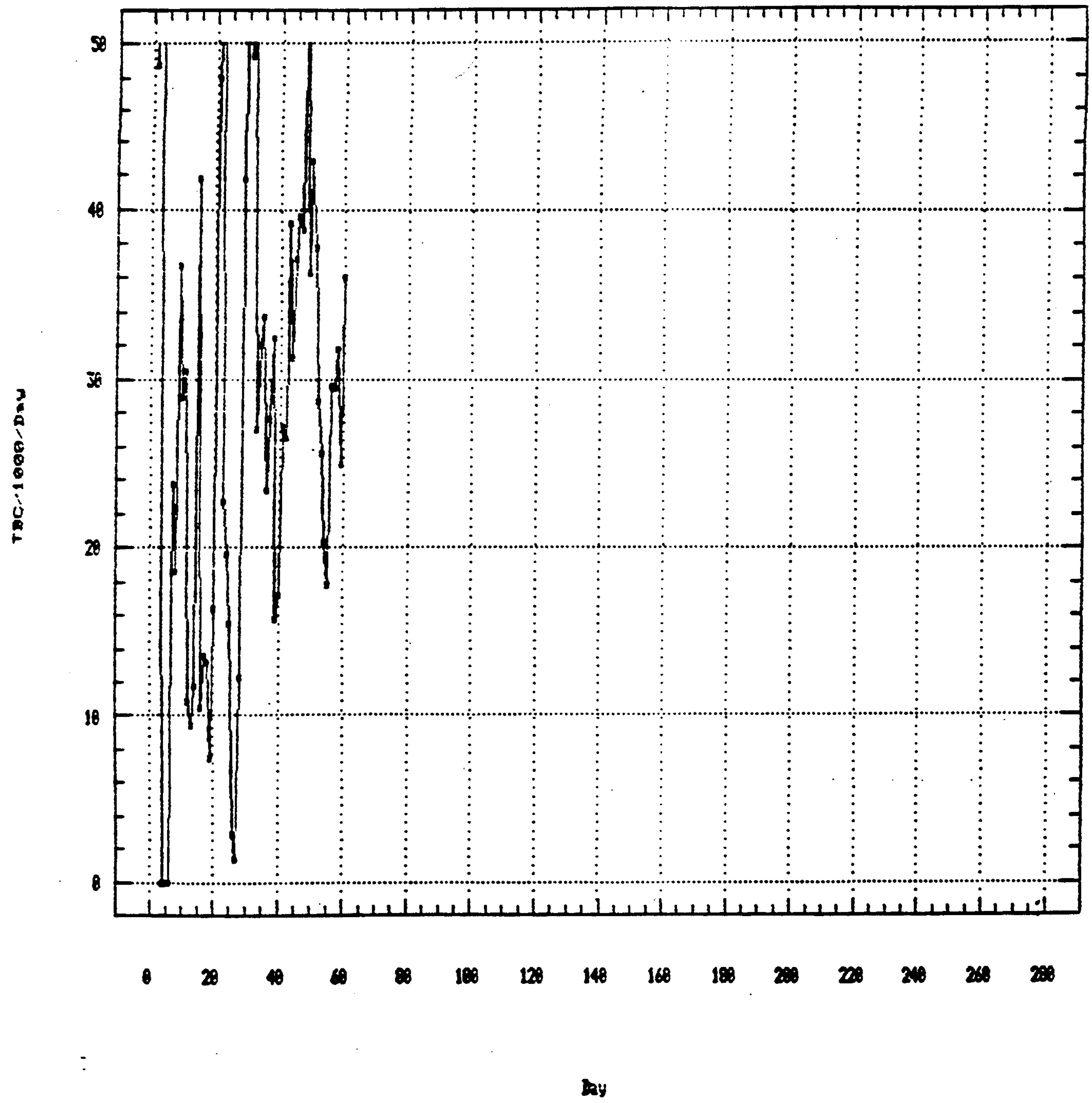
50
40
30
20
10
0
TBC/1000/Day
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '12'



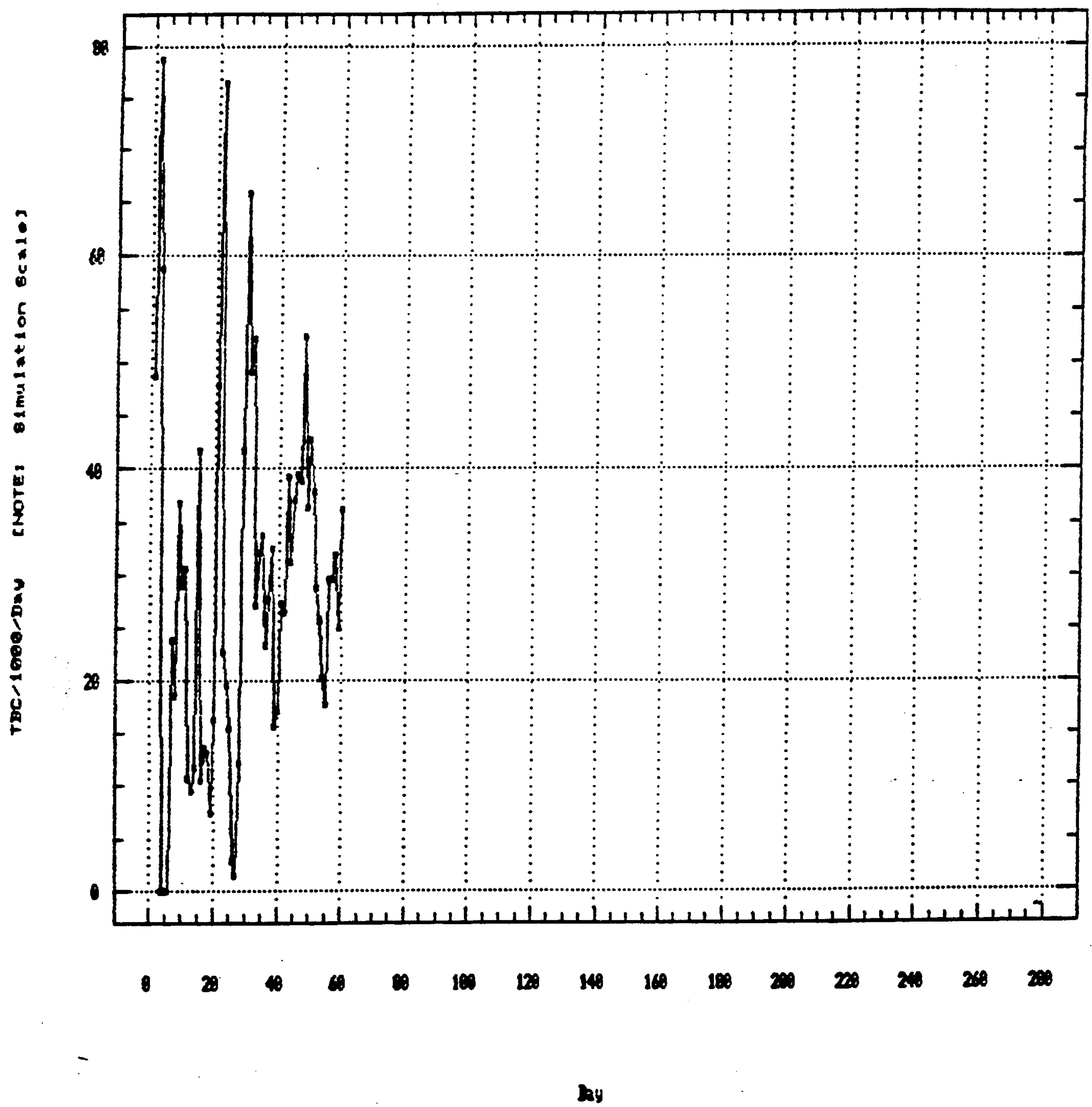
TBC/1000/Day [NOTE: Simulation Scale]
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '13'



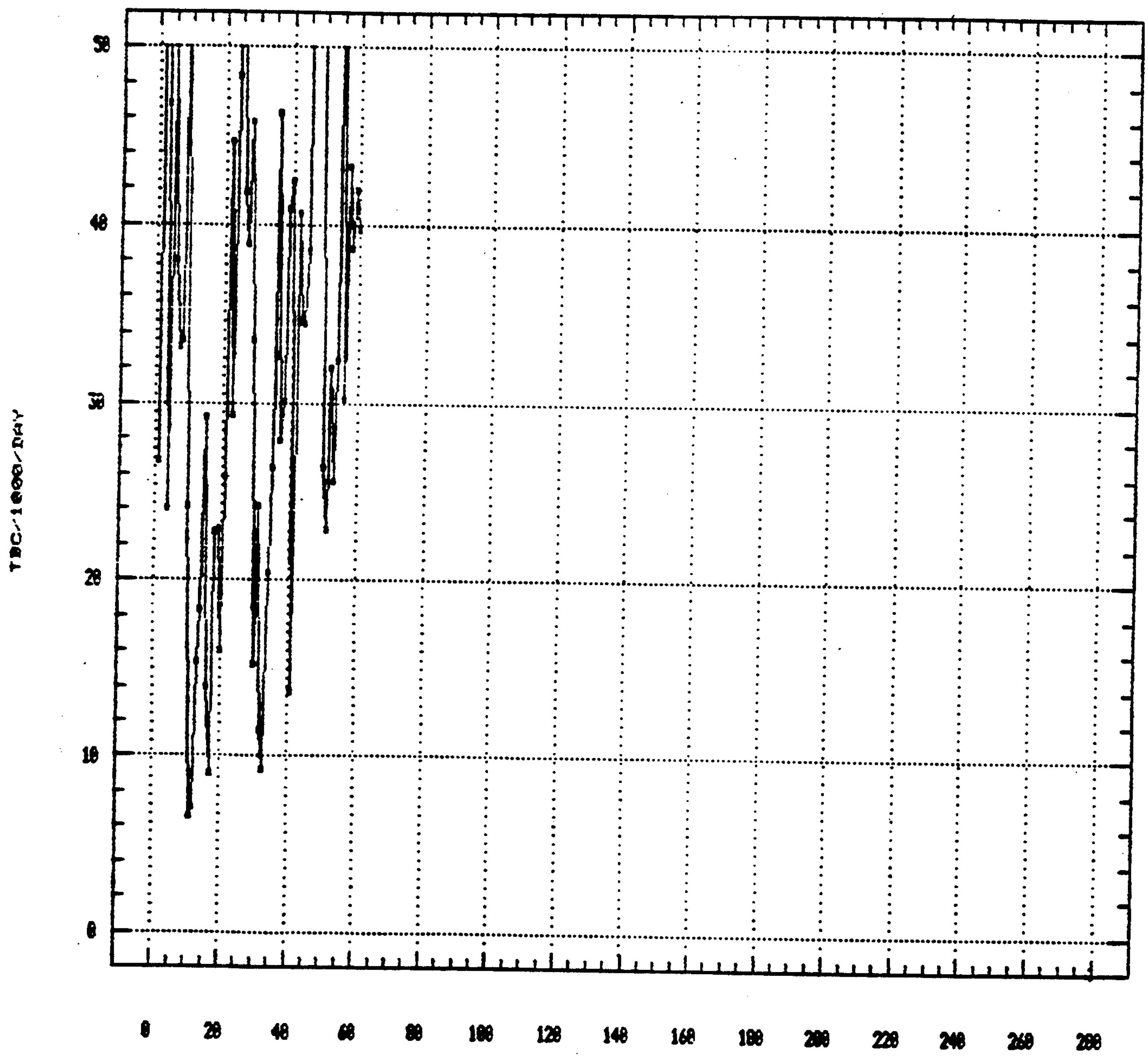
50
40
30
20
10
0
TBC/1000/Day
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '13'



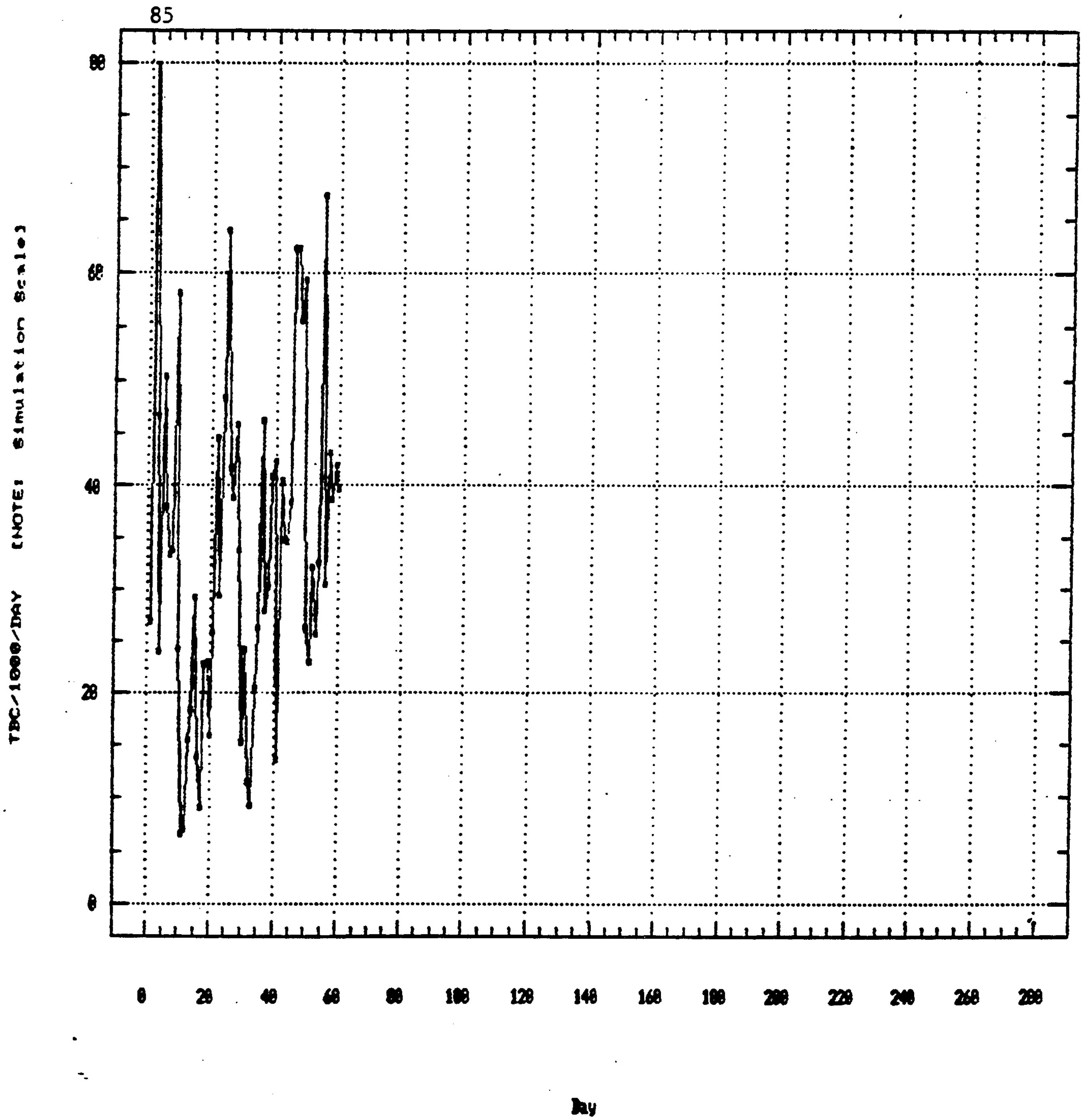
TBC/1000/Day (NOTE: Simulation Scale)
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '14'

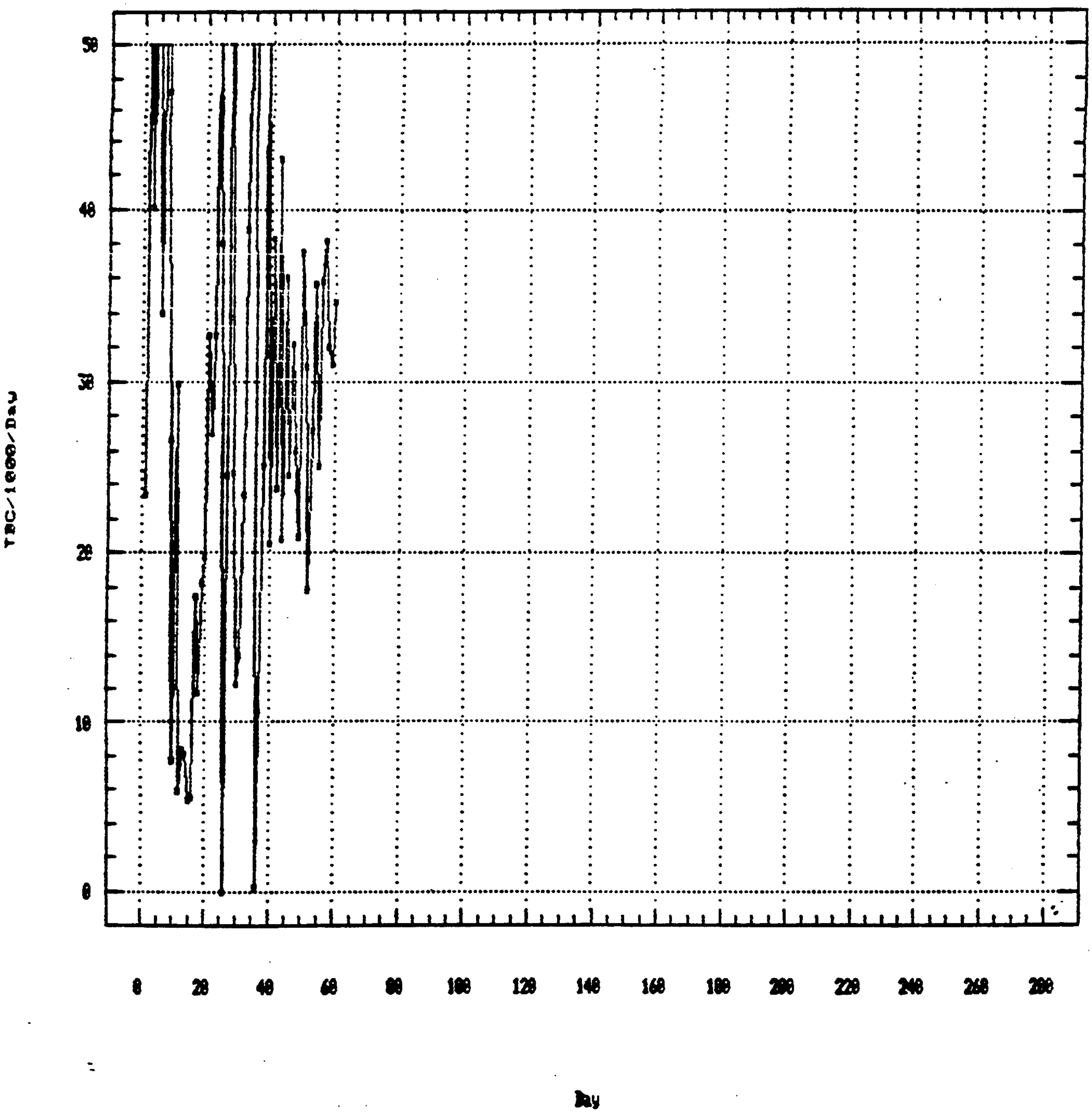


TBC/1000/DAY
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '14'

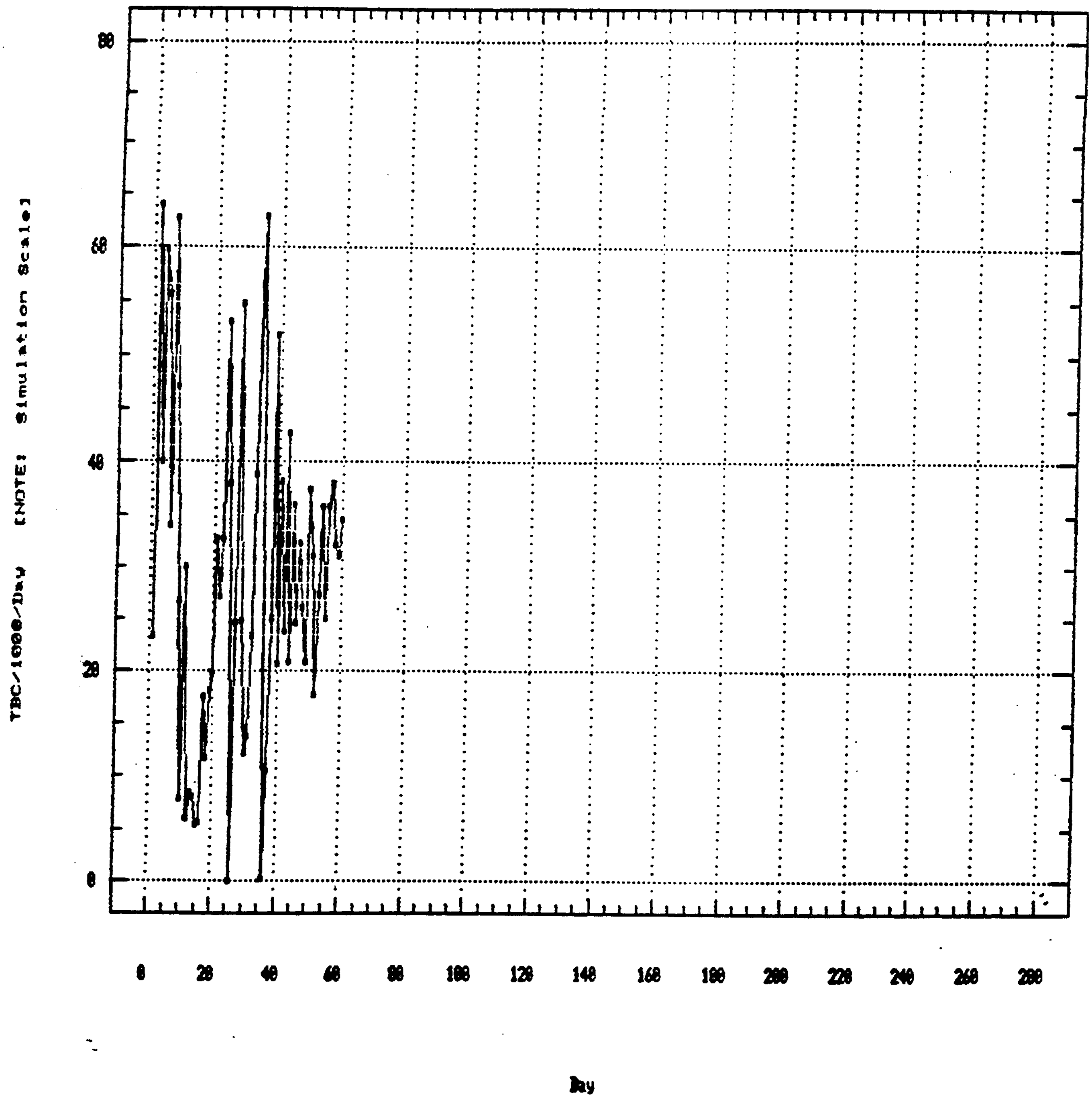

85
80
60
40
20
0
TBC/1000/DAY [NOTE: Simulation Scale]
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '15'



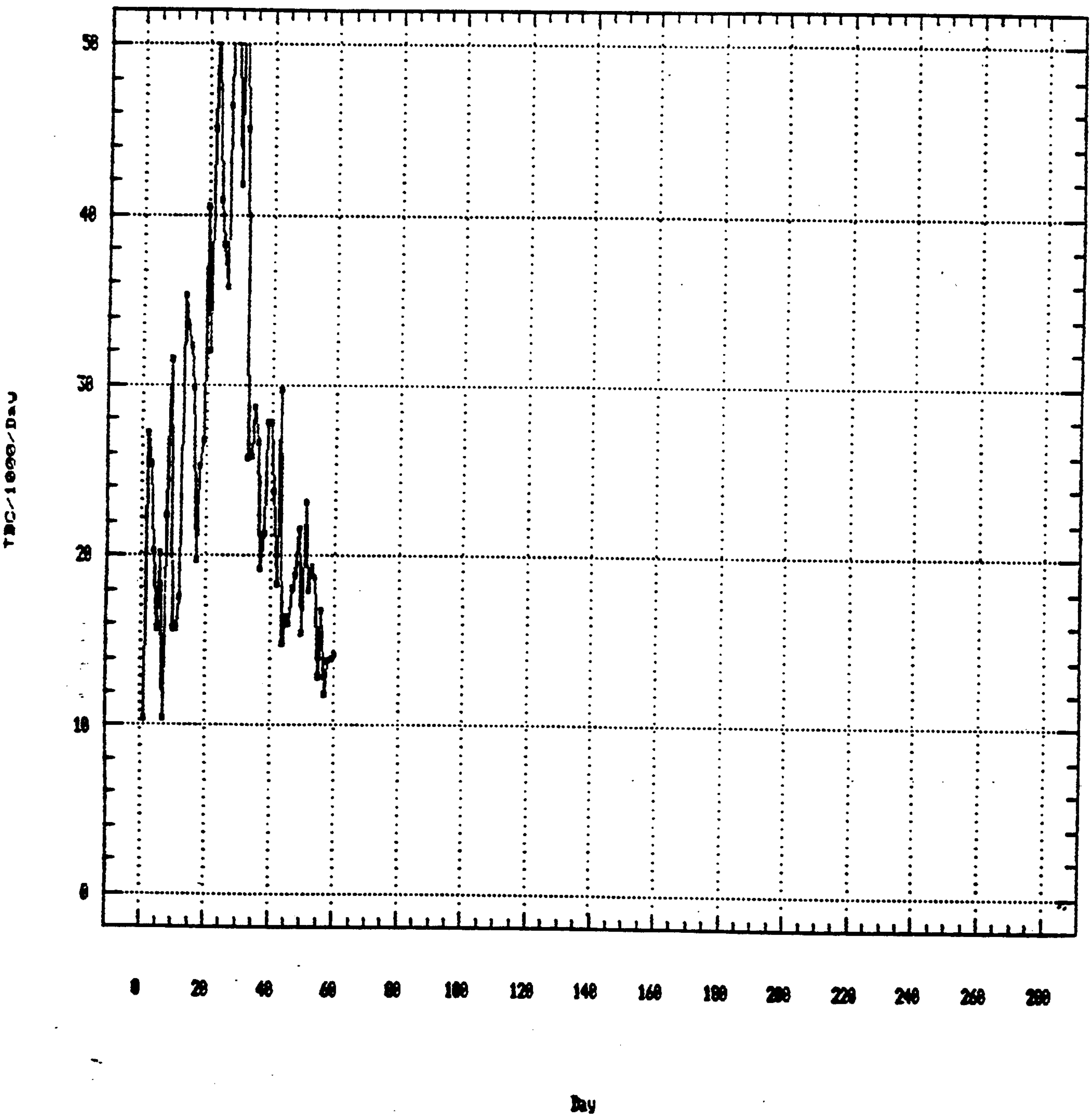
TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '15'



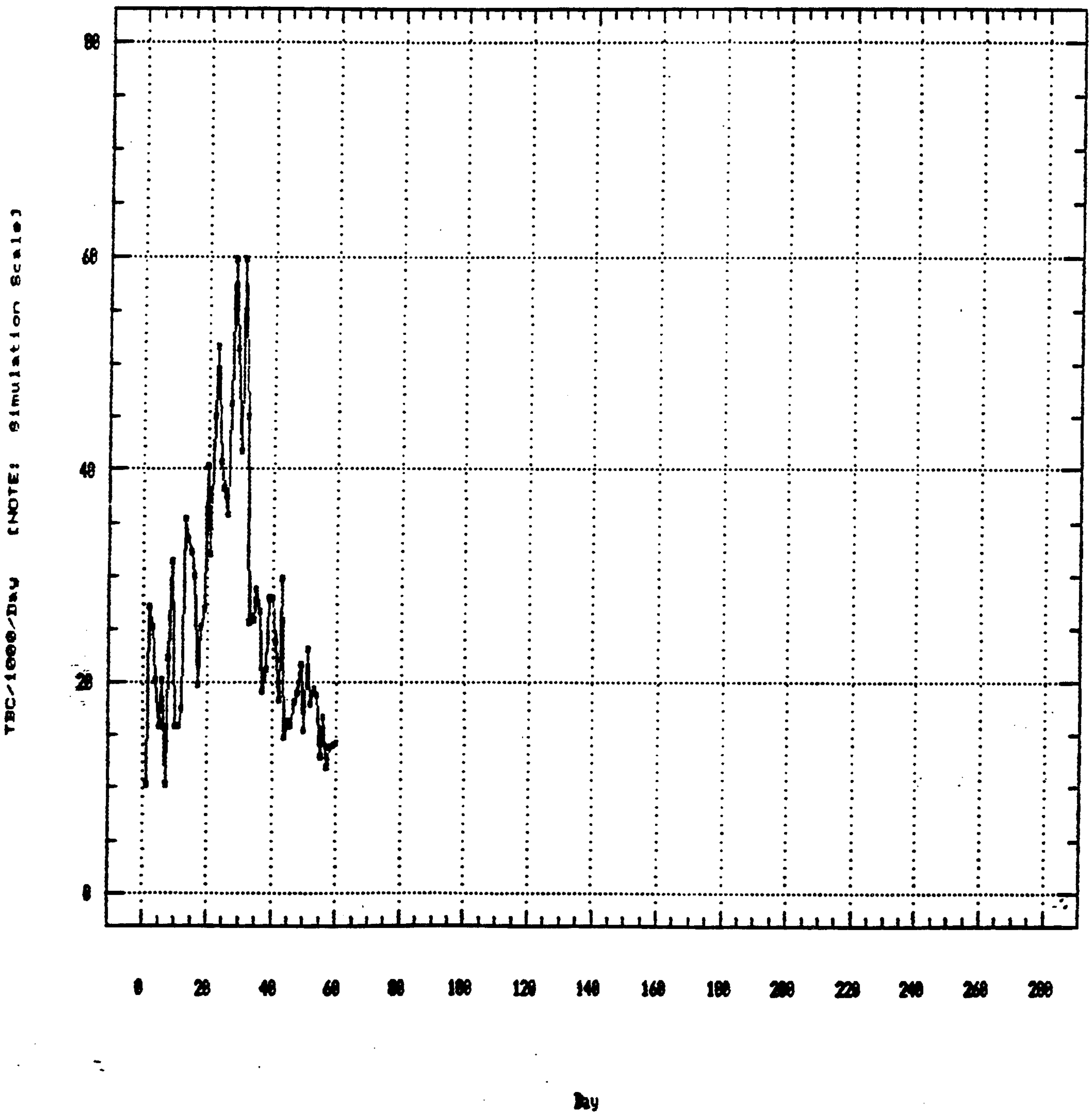
TBC/1000/Day [NOTE: Simulation Scale]
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '16'



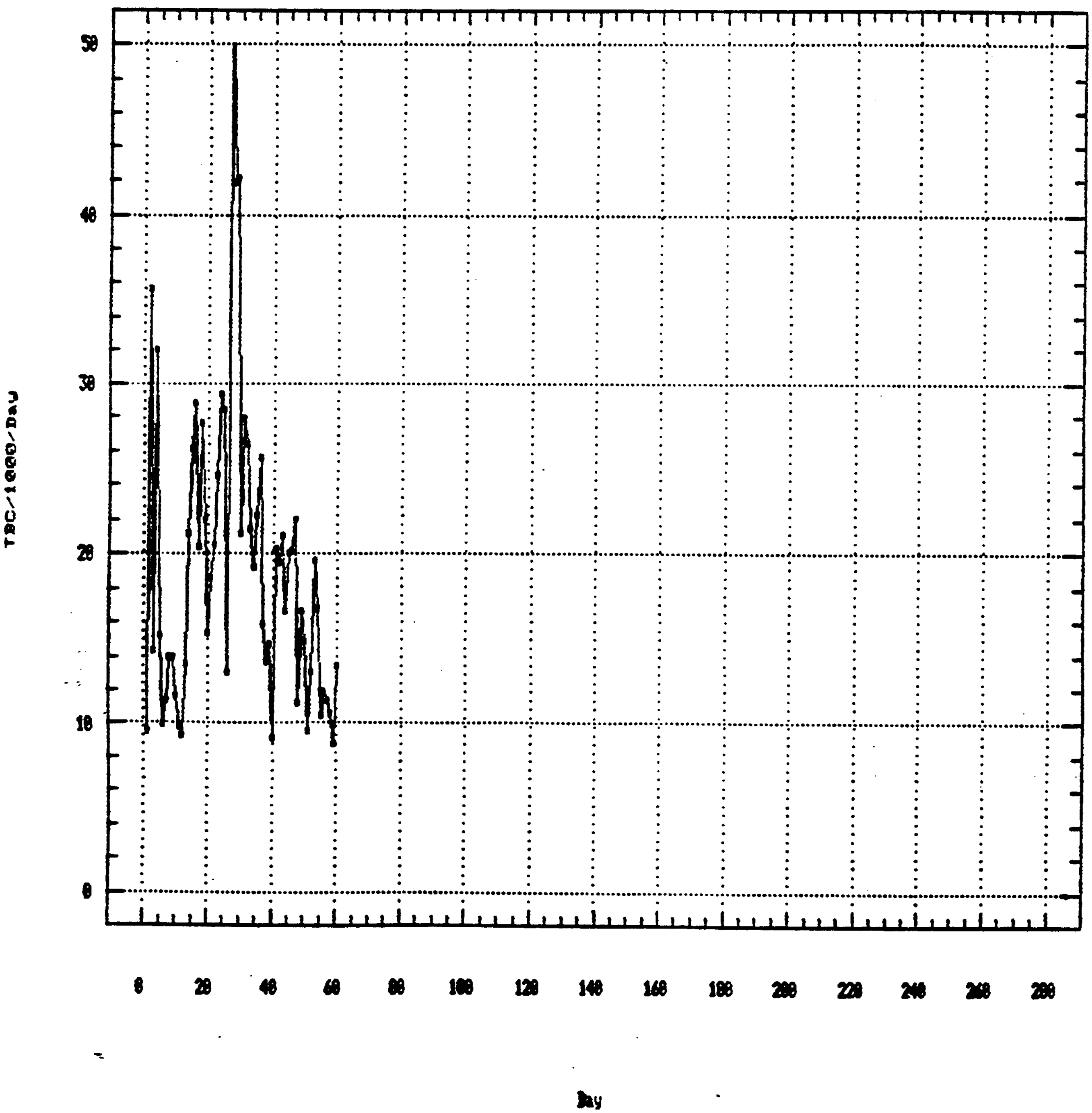
TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '16'



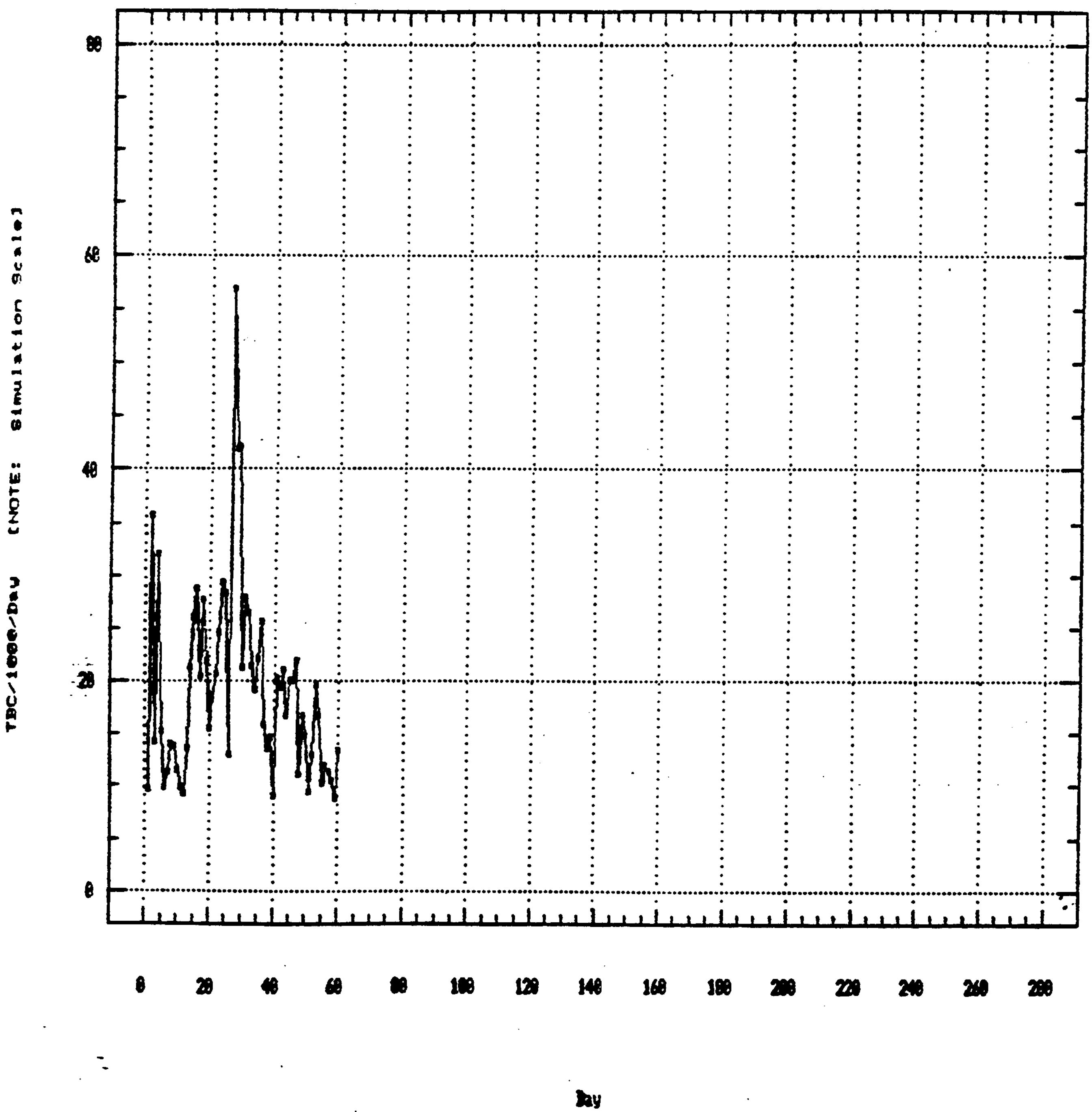
80
60
40
20
0
TBC/1000/Day (NOTE: Simulation Scale)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '17'



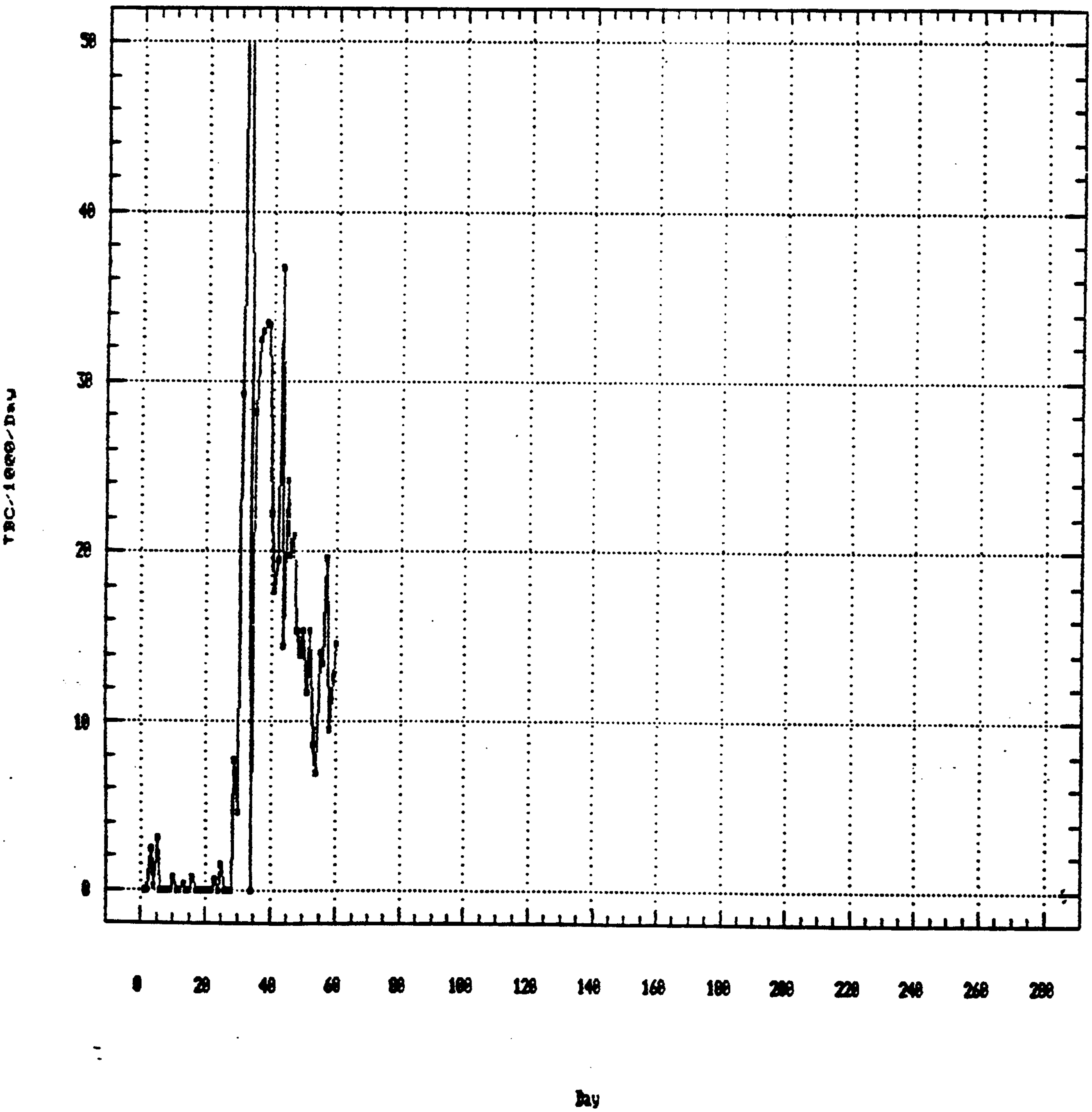
TBC/1000/Day
0
10
20
30
40
50
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '17'



TBC/1000/Day [NOTE: Simulation Scale]
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '18'



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40
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20
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0
TBC/1000/Day
0
20
40
60
80
100
120
140
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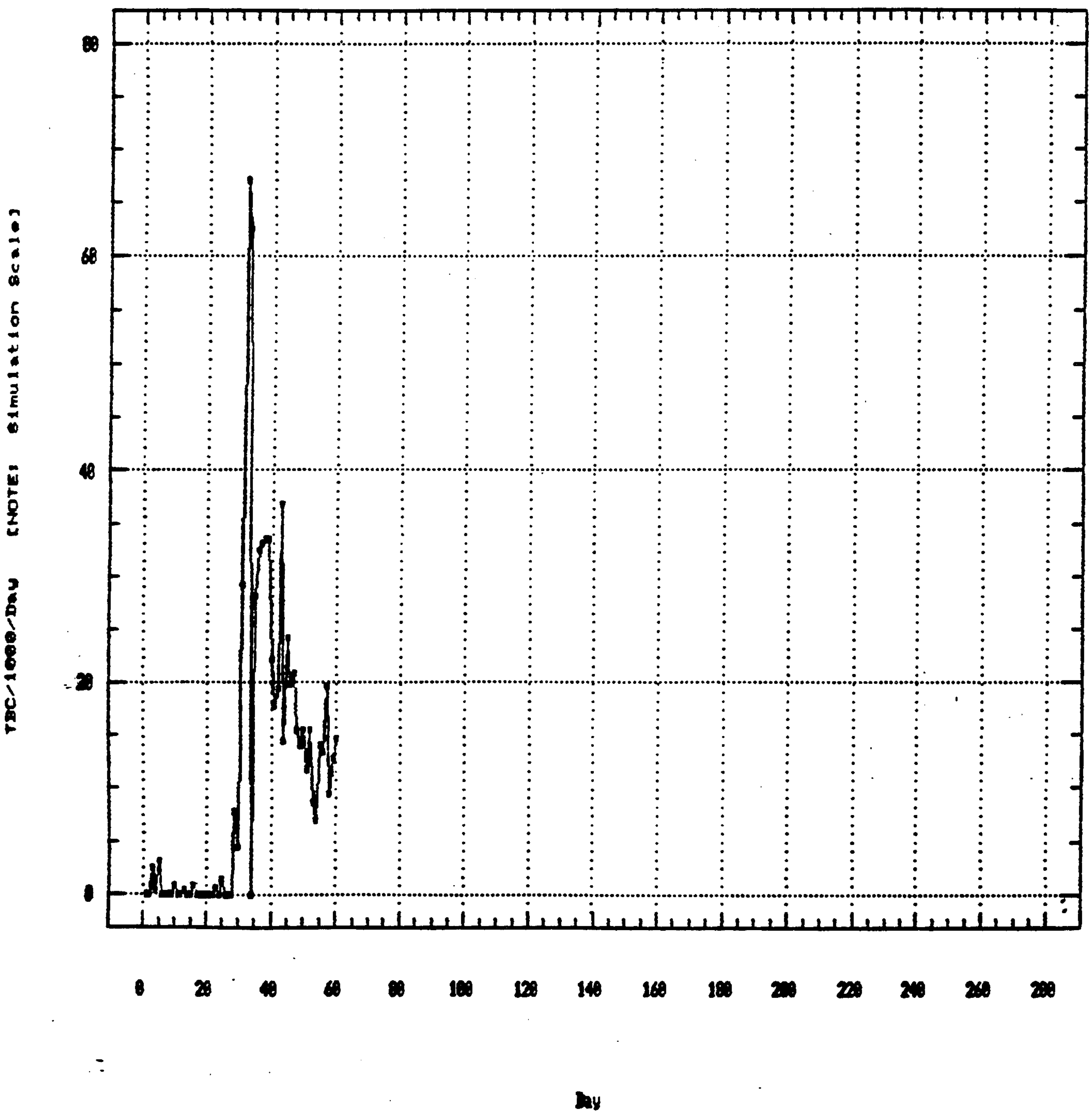
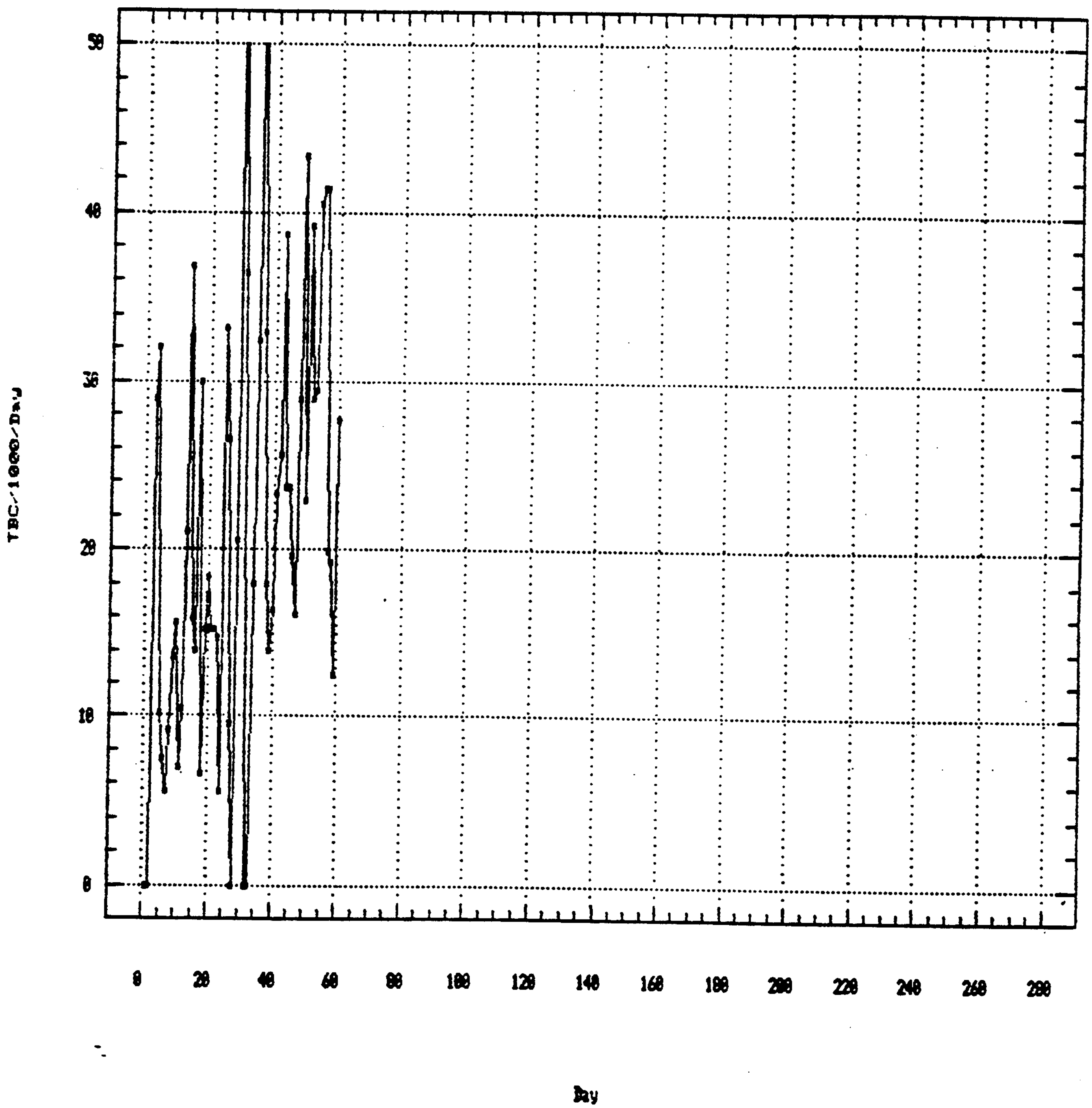
200
220
240
260
280
Day

Division '18'



80
60
40
20
0
TBC/1000/Day (NOTE: Simulation Scale)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '19'



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0
TBC/1000/Day
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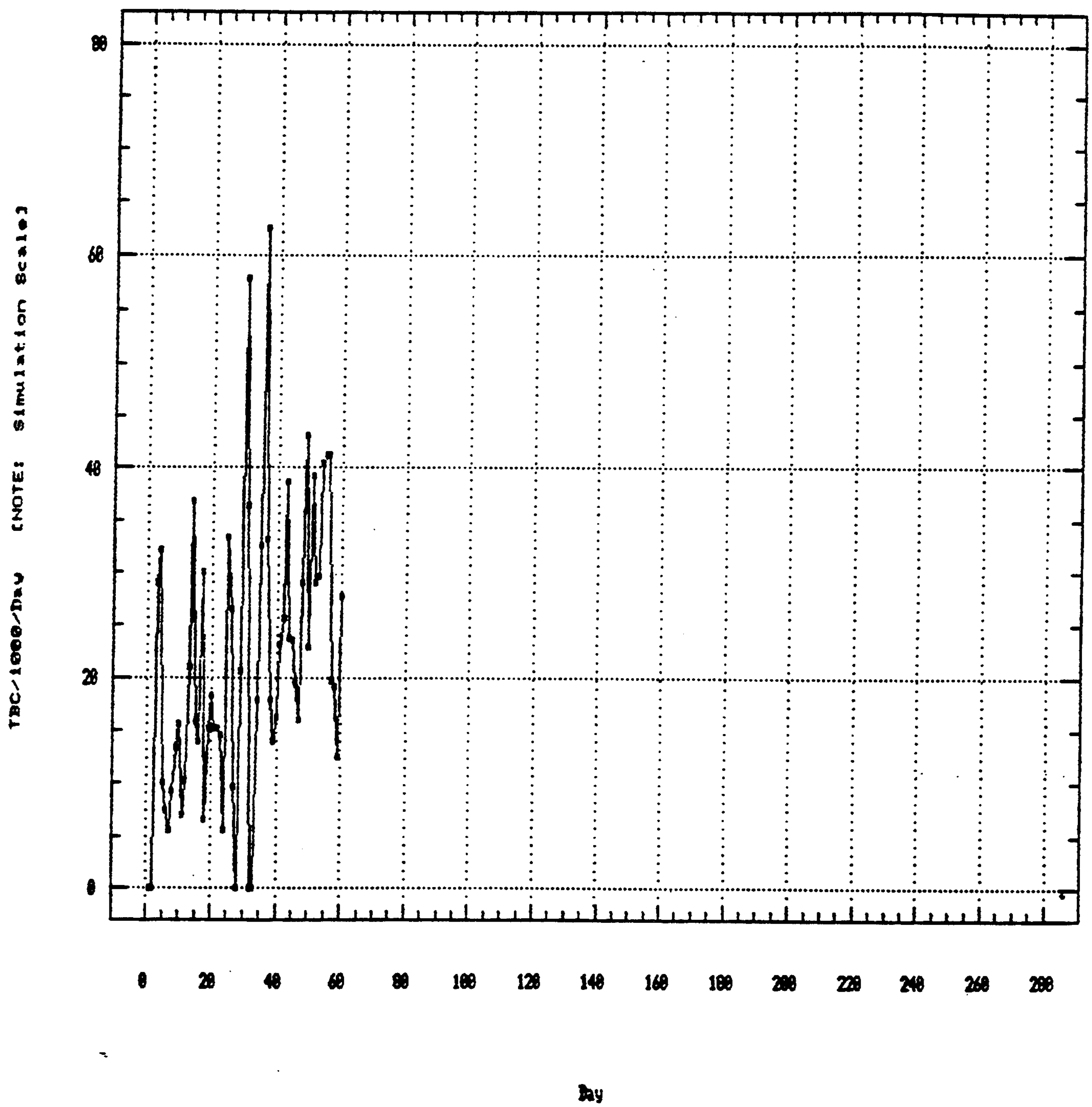
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '19'


TBC/1000/Day (NOTE: Simulation Scale)
80
60
40
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0
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40
60
80
100
120
140
160
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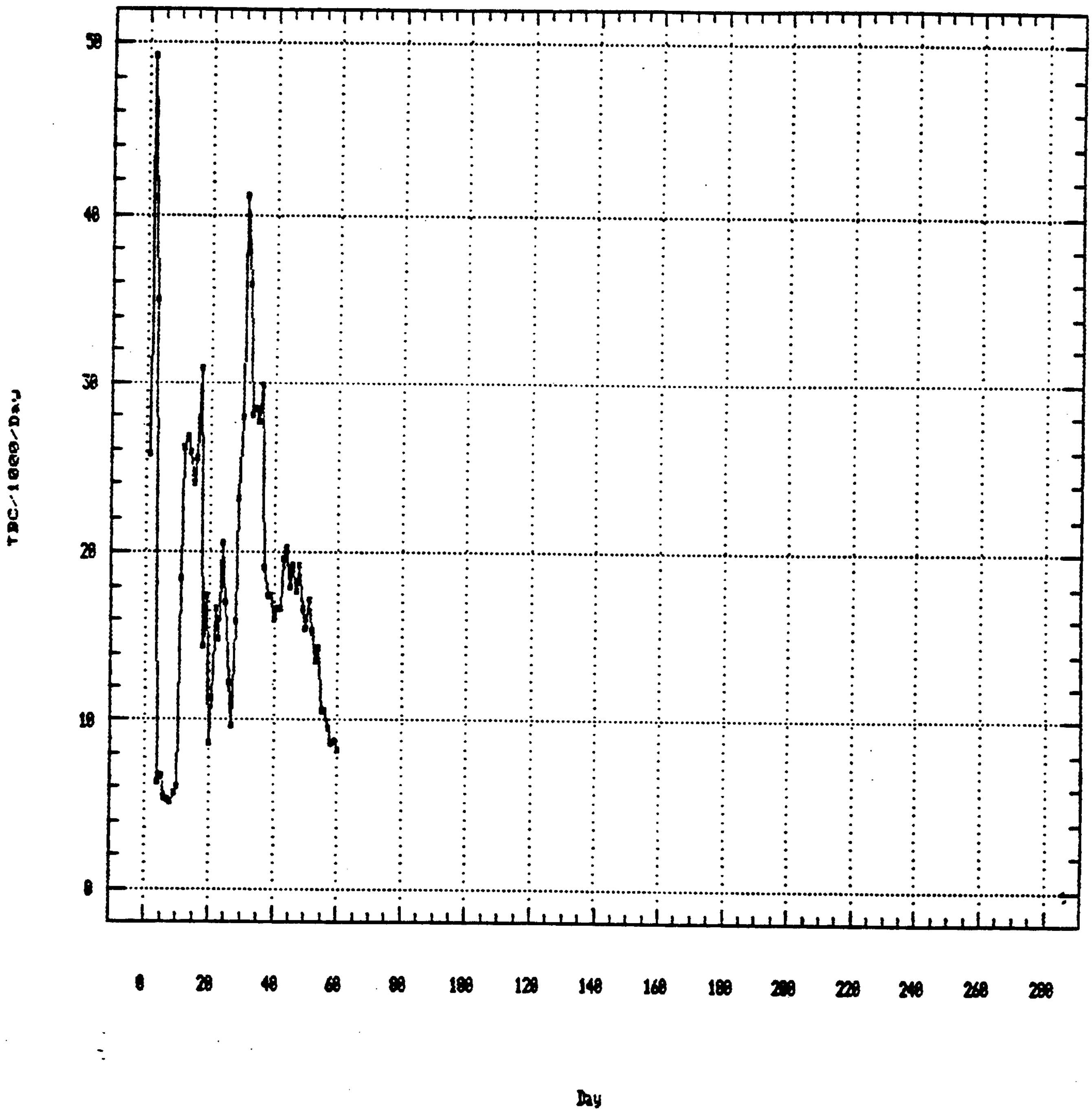
260
280
Day

Division '20'


TBC/1000/Day
0
10
20
30
40
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0
20
40
60
80
100
120
140
160
180
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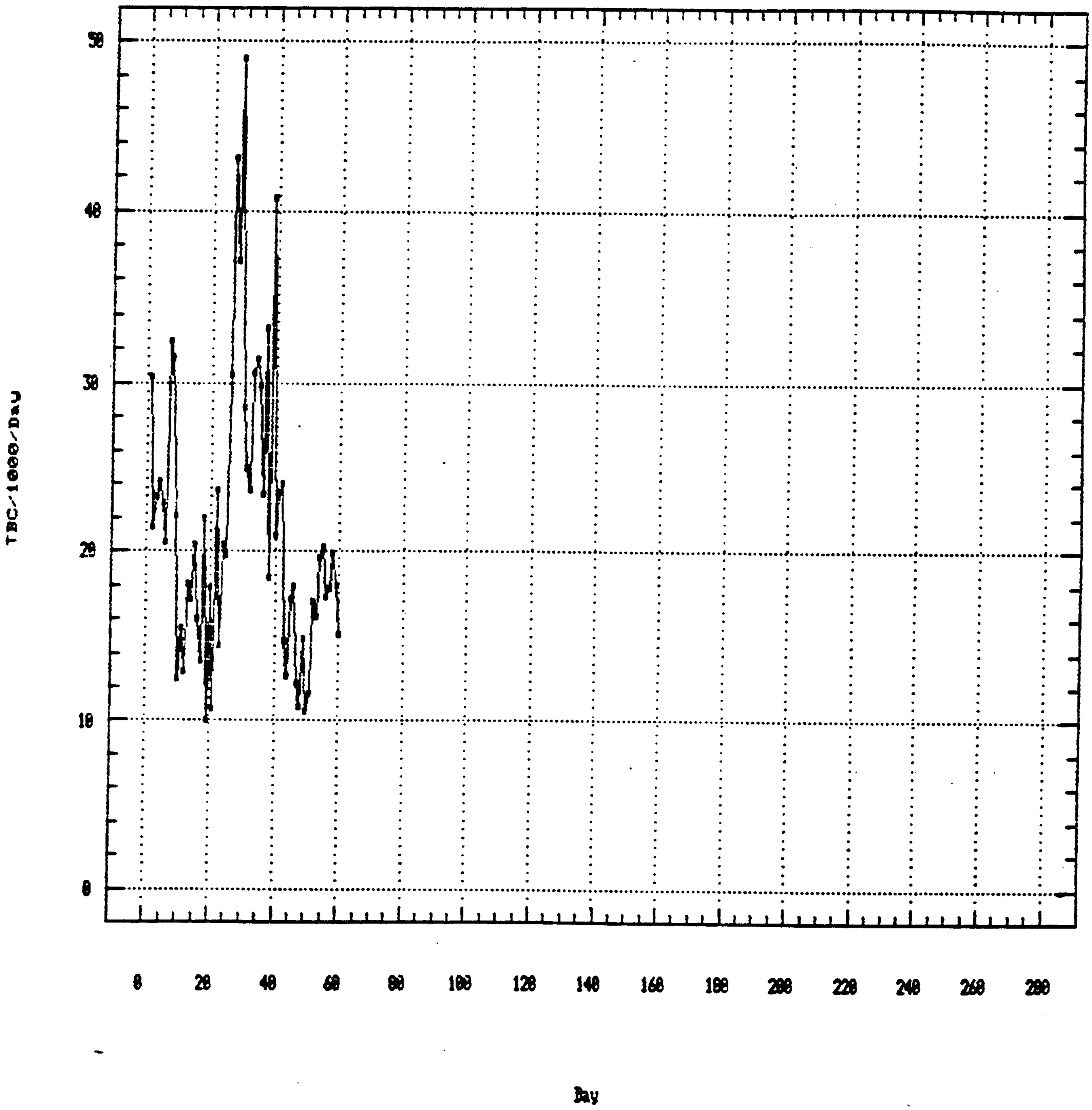
260
280
Day

Division '21'



TBC/1000/Day
50
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20
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0
20
40
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80
100
120
140
160
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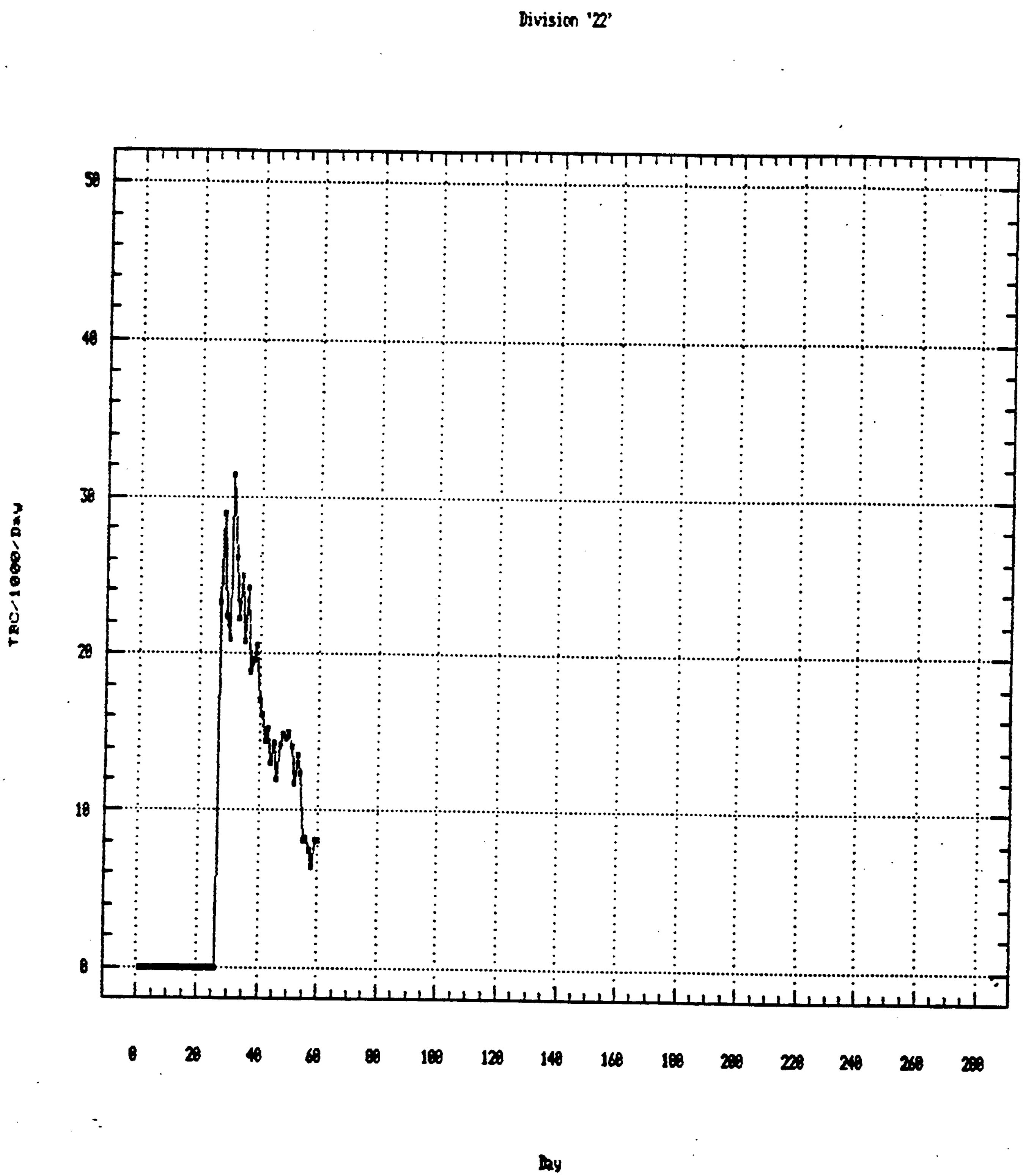
200
220
240
260
280
Day


Division '22'
TRC/1000/Day
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40
30
20
10
0
0
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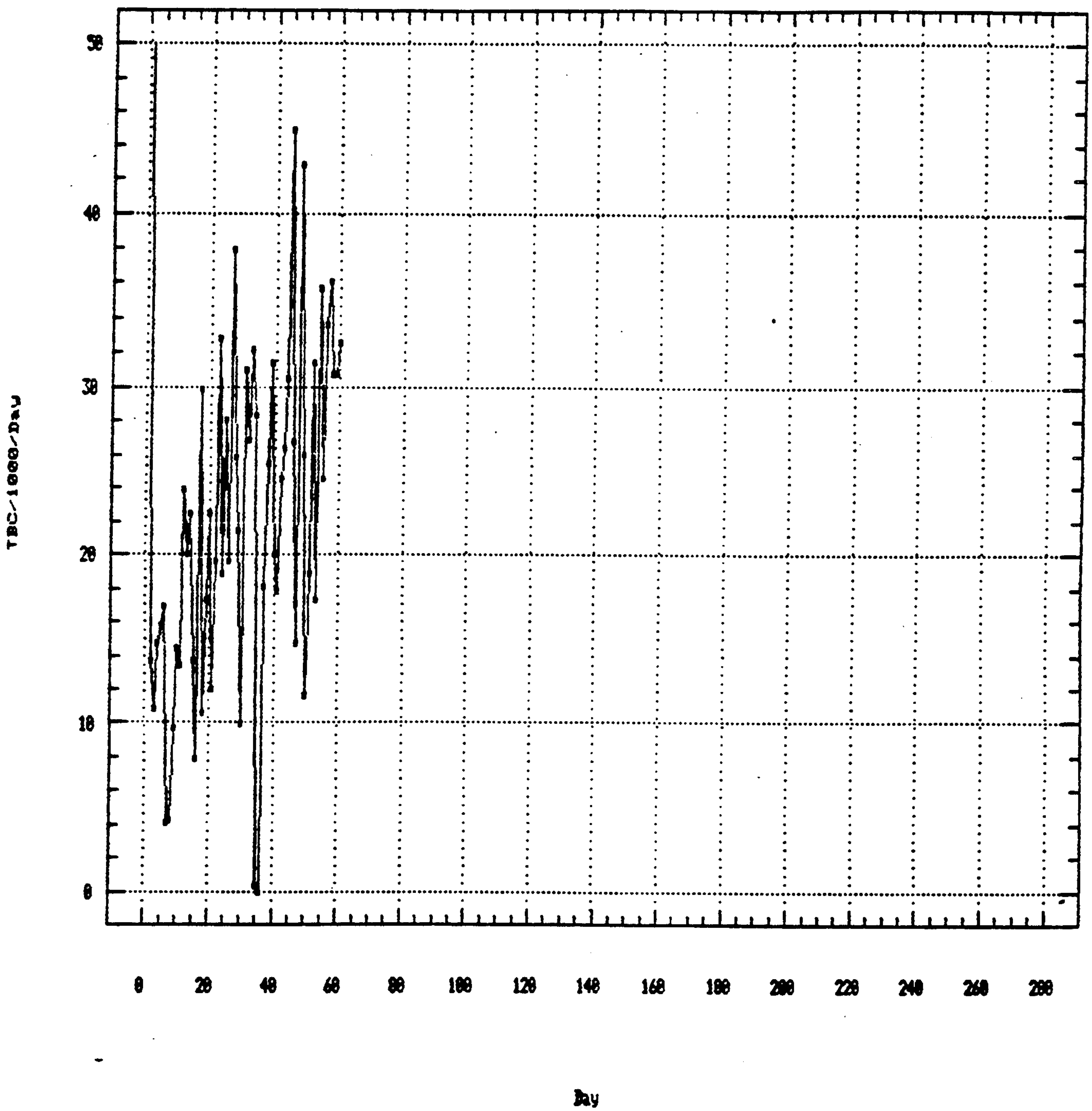
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '23'


TBC/1000/Day
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40
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20
10
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0
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40
60
80
100
120
140
160
180
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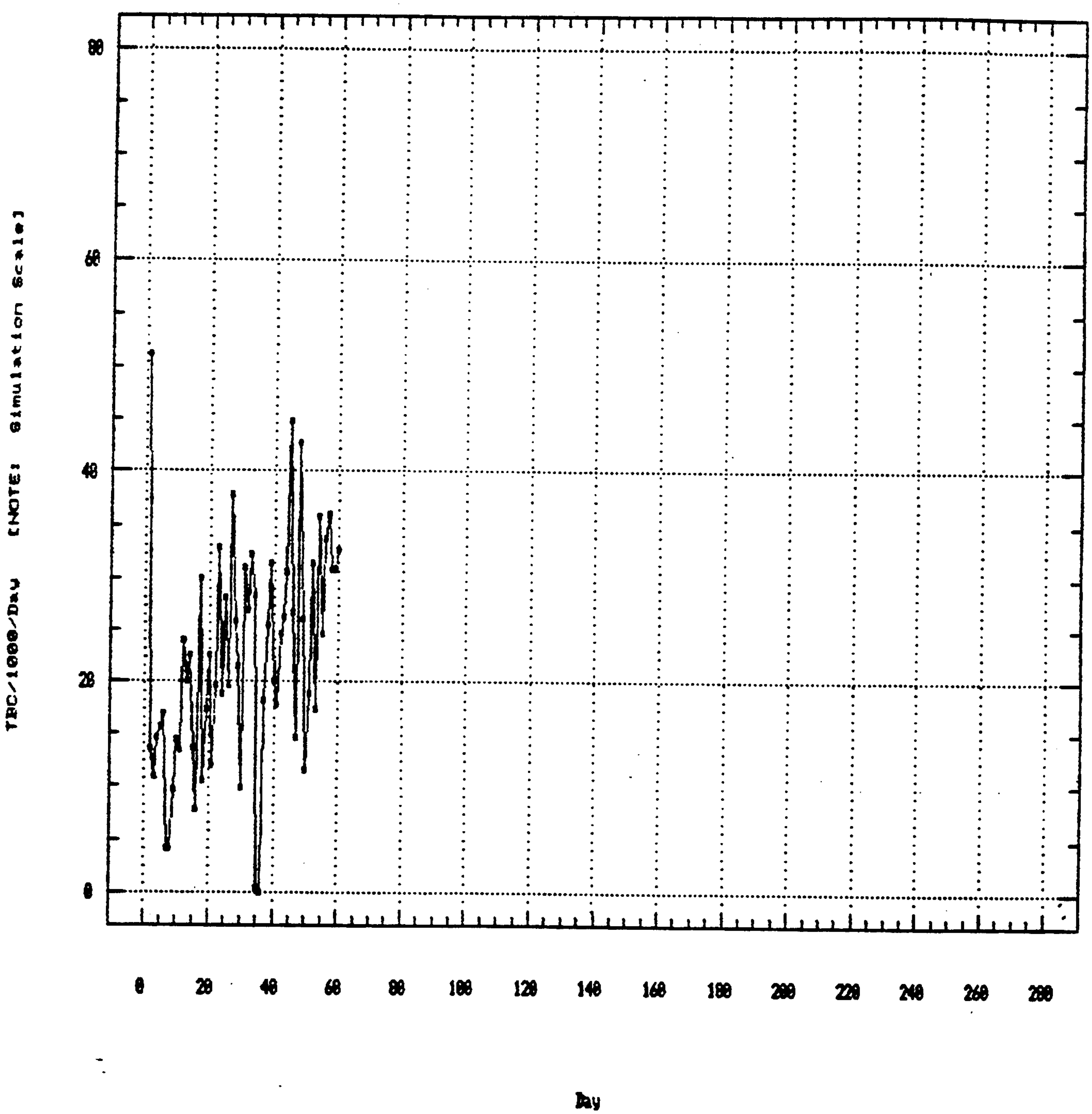
240
260
280
Day

Division '23'



80
60
40
20
0
TBC/1000/Day [NOTE: Simulation Scale]
0
20
40
60
80
100
120
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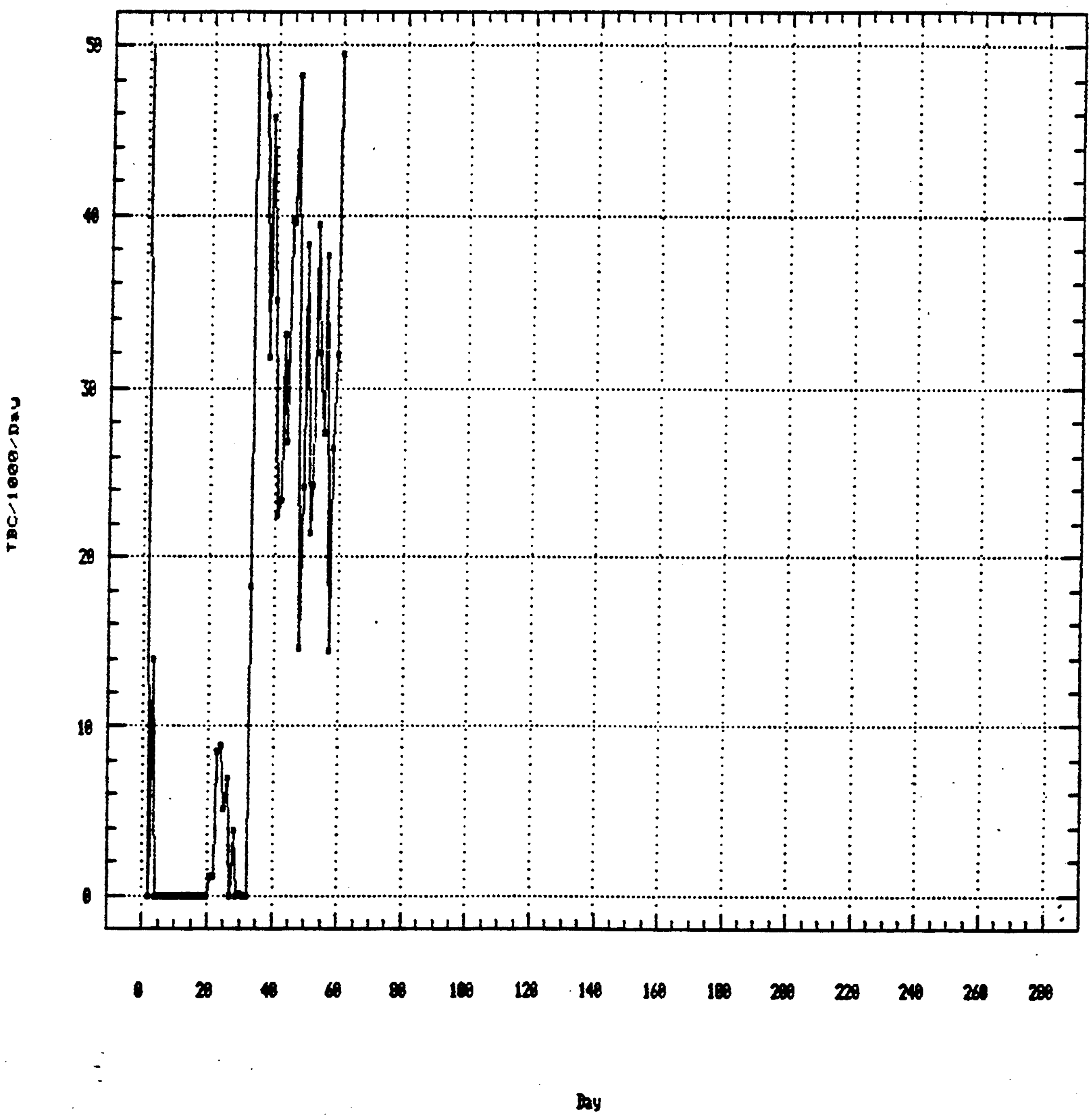
160
180
200
220
240
260
280
Day

Division '24'



TBC/1000/Day
0
10
20
30
40
50
0
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40
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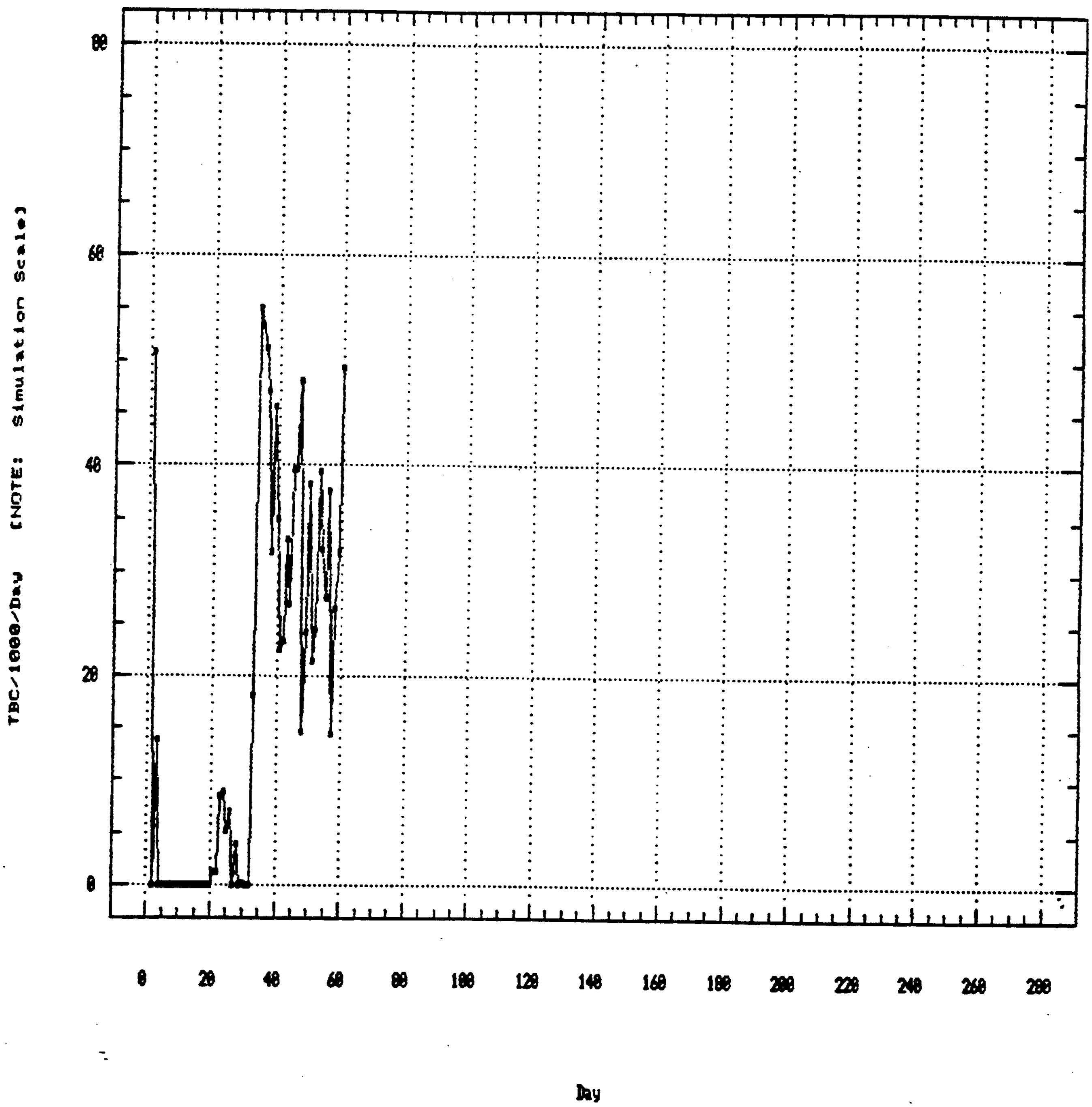
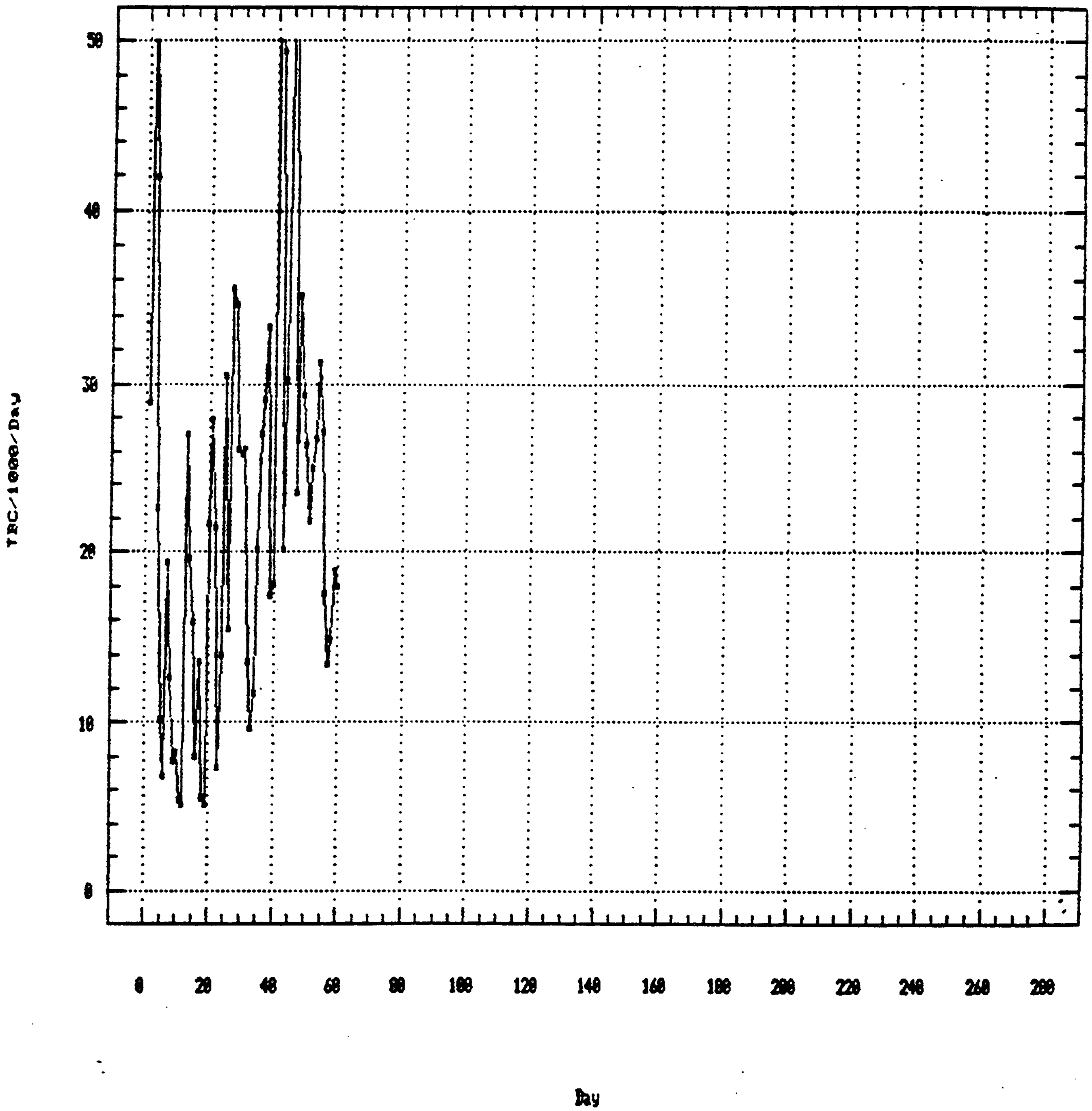
80
100
120
140
160
180
200
220
240
260
280
Day

Division '24'



TBC/1000/Day (NOTE: Simulation Scale)
0
20
40
60
80
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '25'



50
40
30
20
10
0
TRC/1000/Day
0
20
40
60
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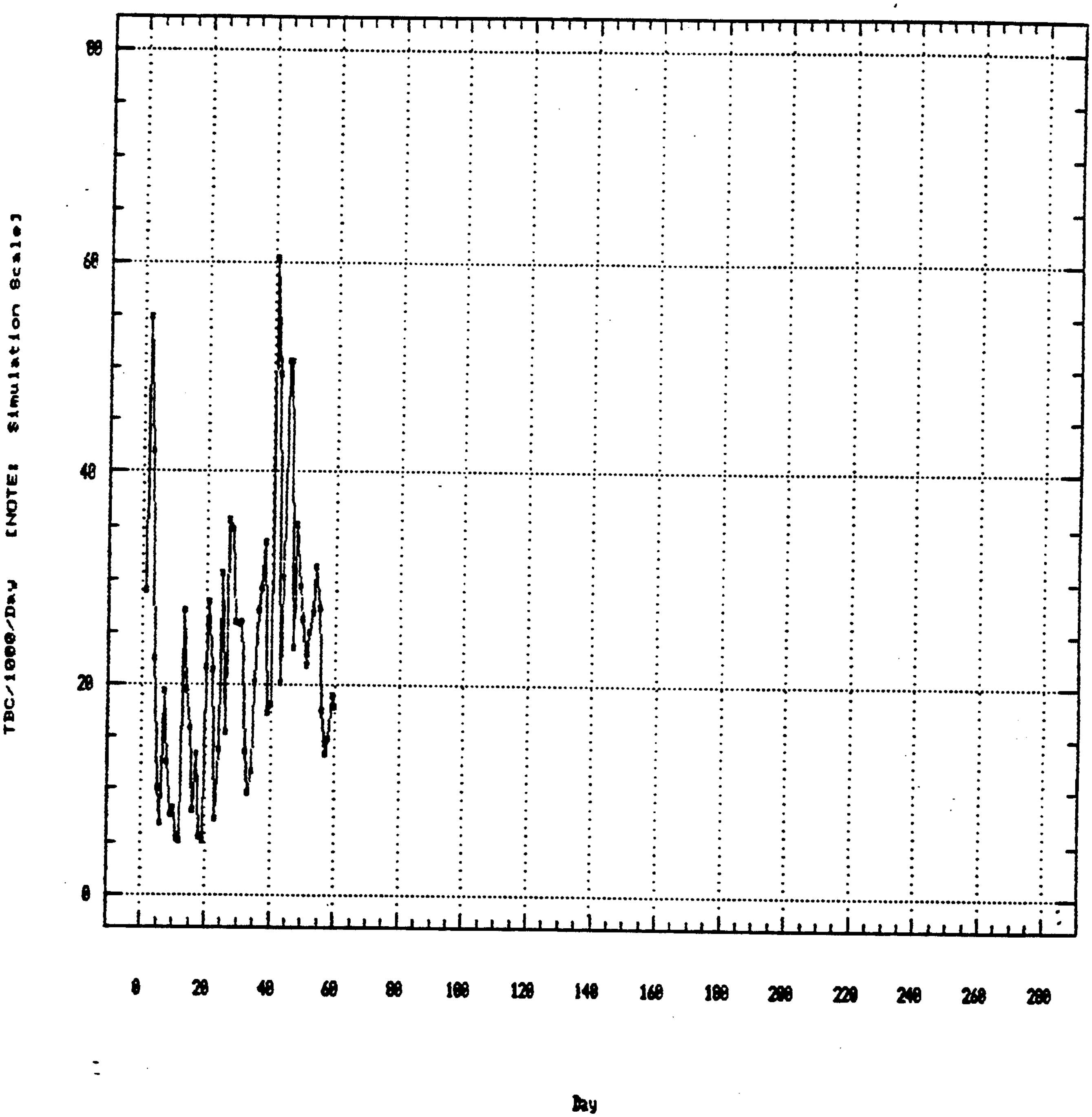
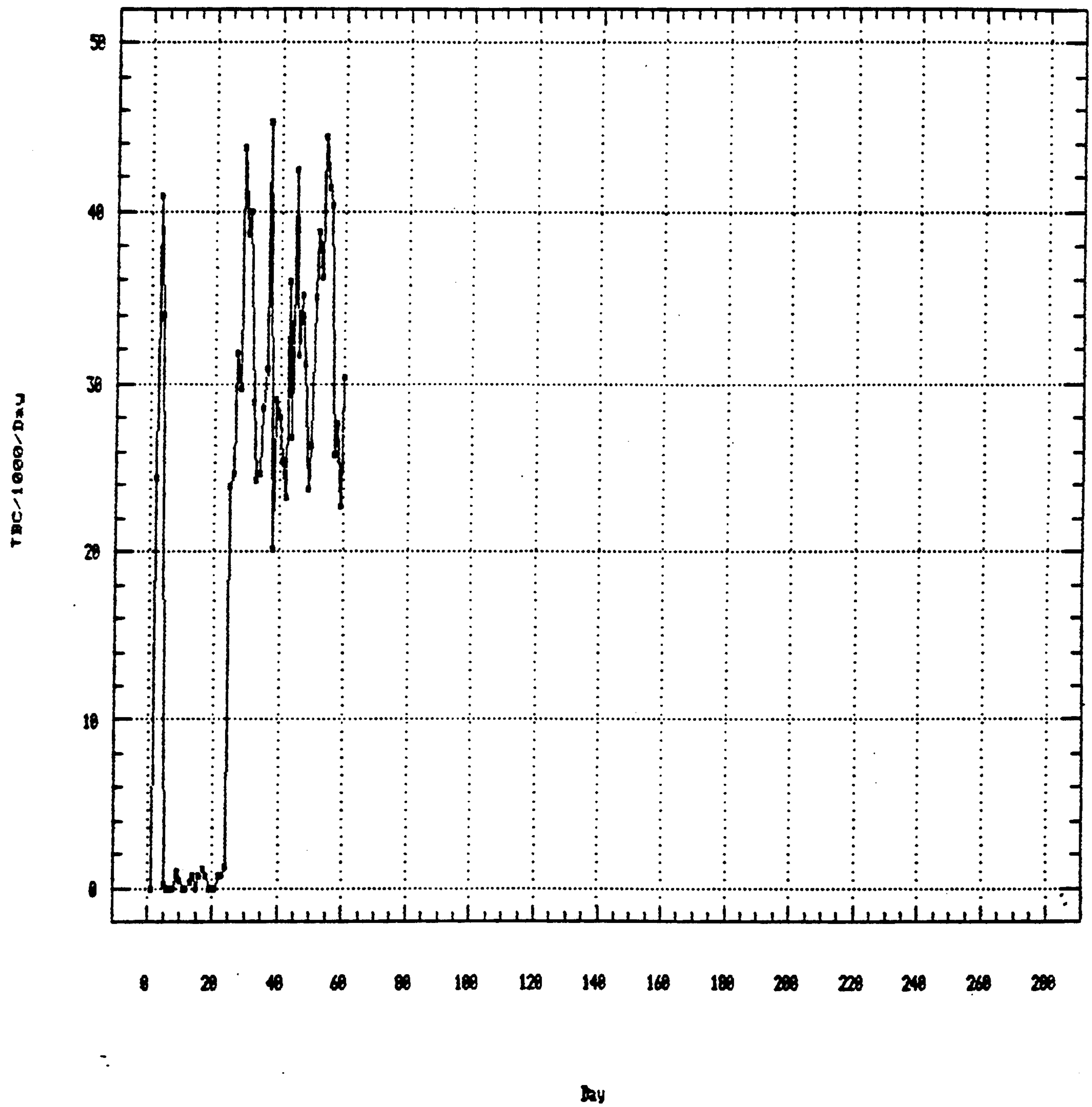
100
120
140
160
180
200
220
240
260
280
Day

Division '25'

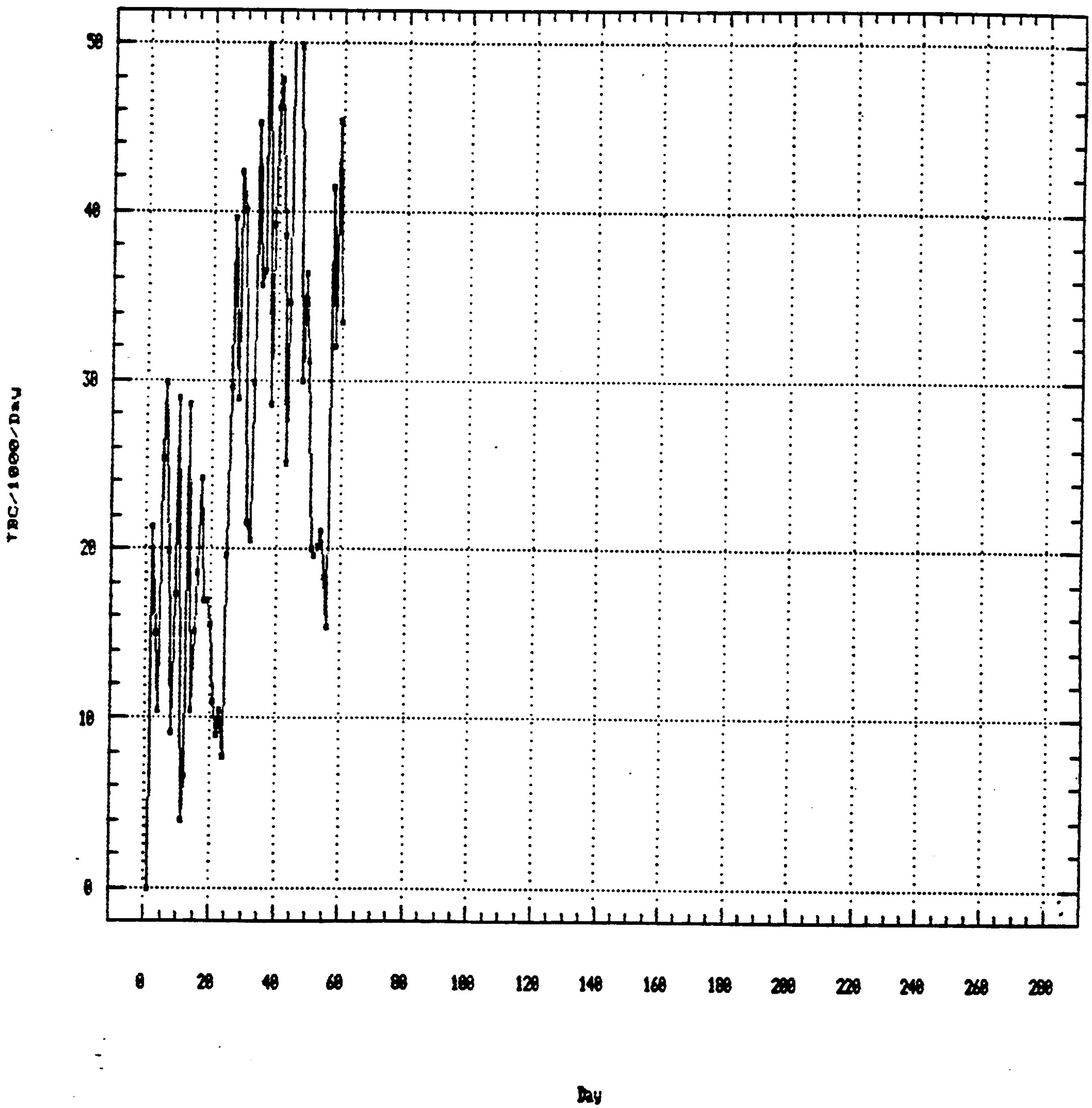


TBC/1000/Day [NOTE: Simulation Scale]
0
20
40
60
80
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '26'

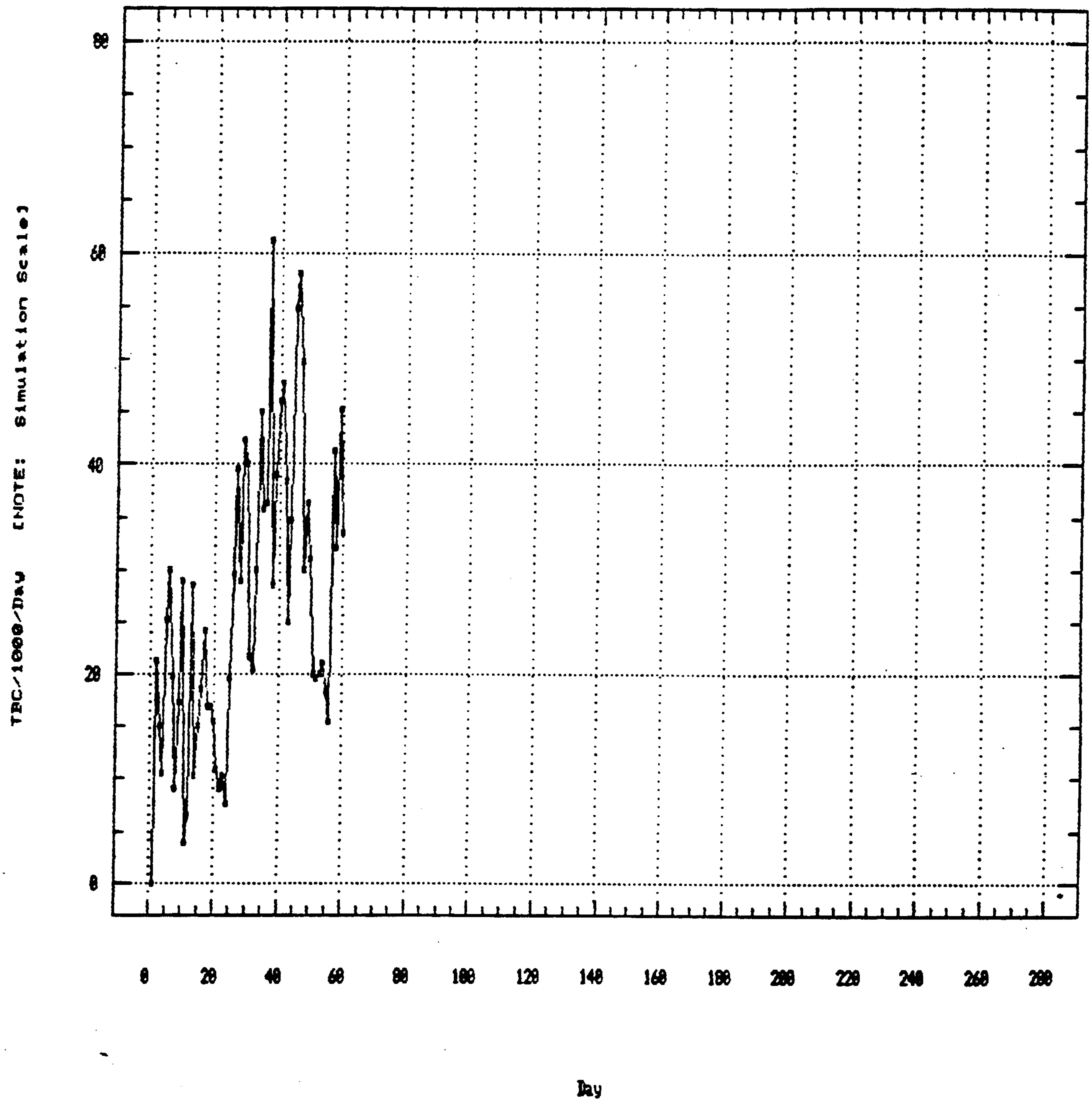

TBC/1000/Day
0
10
20
30
40
50
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '27'



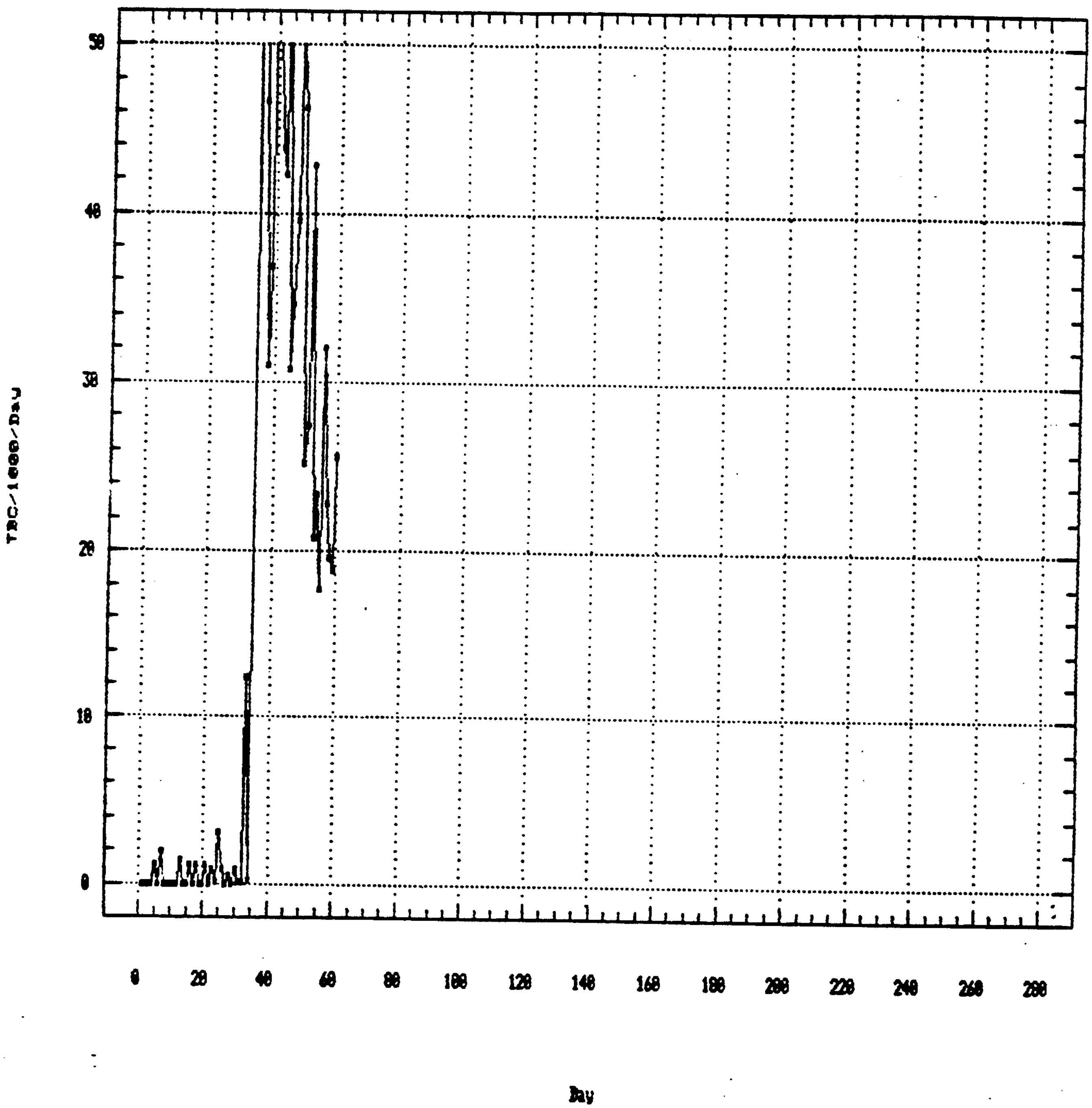
TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '27'



TBC/1000/Day [NOTE: Simulation Scale]
0
20
40
60
80
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '28'



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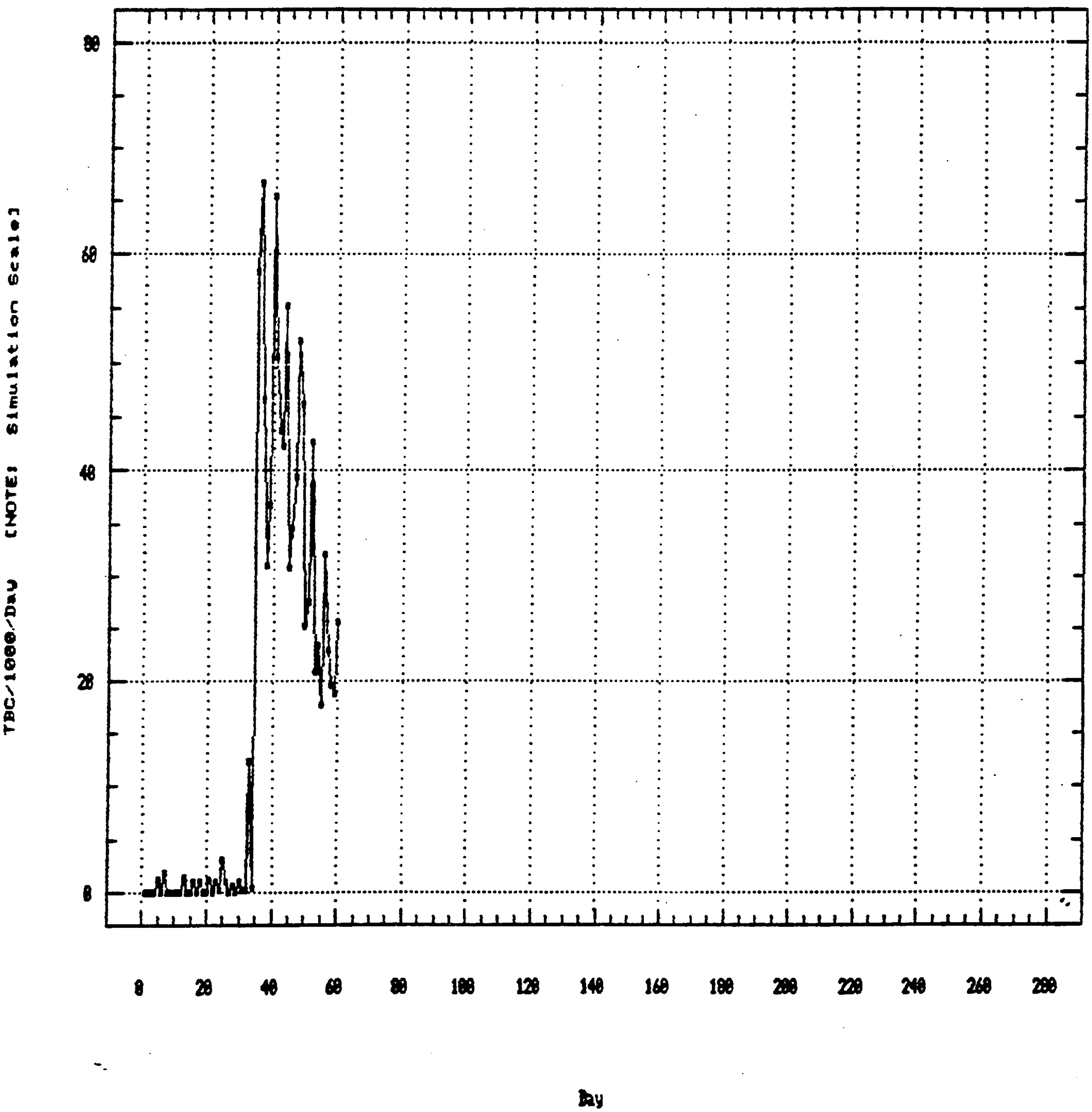
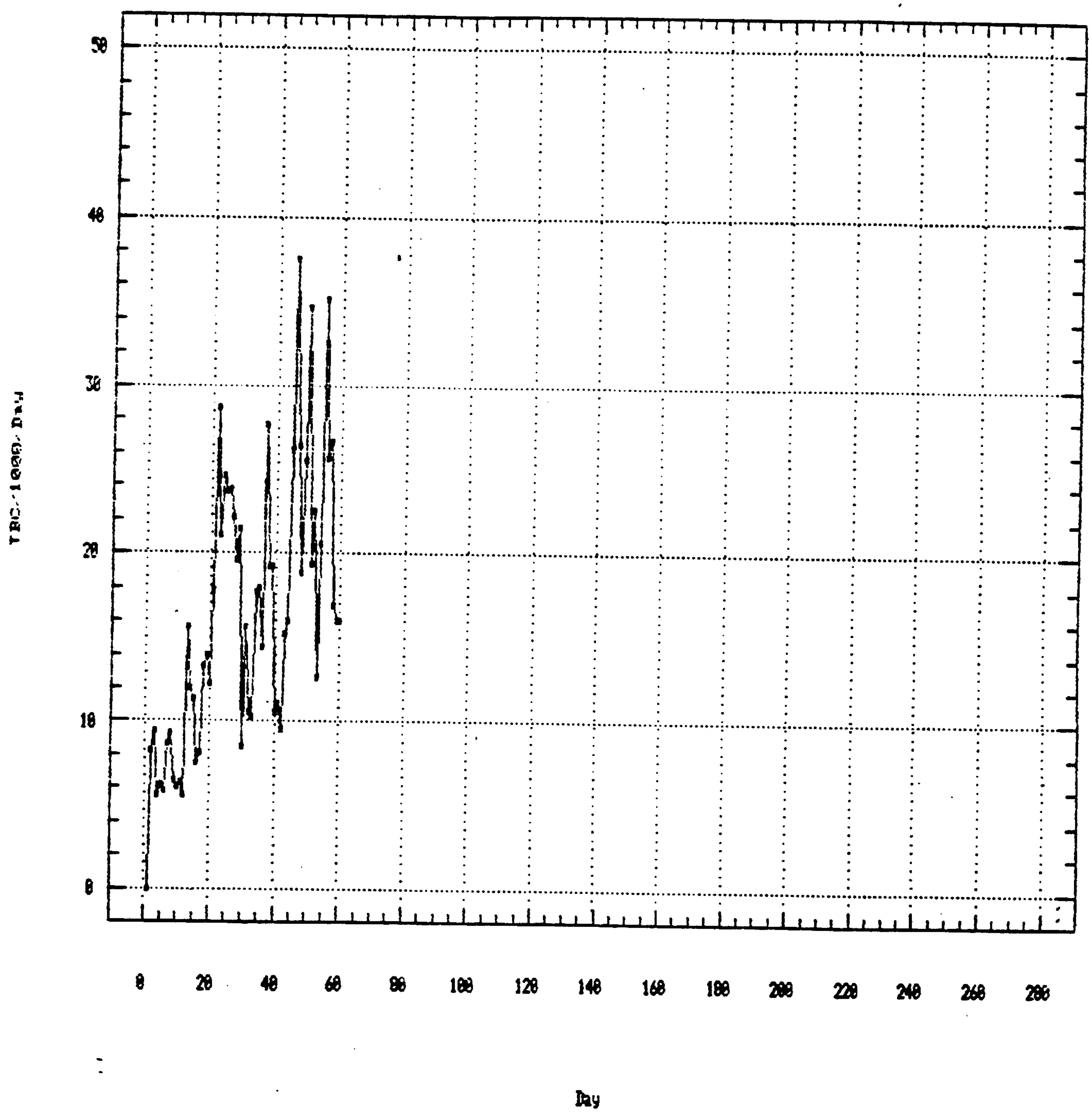
40
30
20
10
0
TRC/1000/Day
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '28'



TBC/1000/Day [NOTE: Simulation Scale]
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '29'



50
40
30
20
10
0
TBC/1000/Day
0
20
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80
100
120
140
160
180
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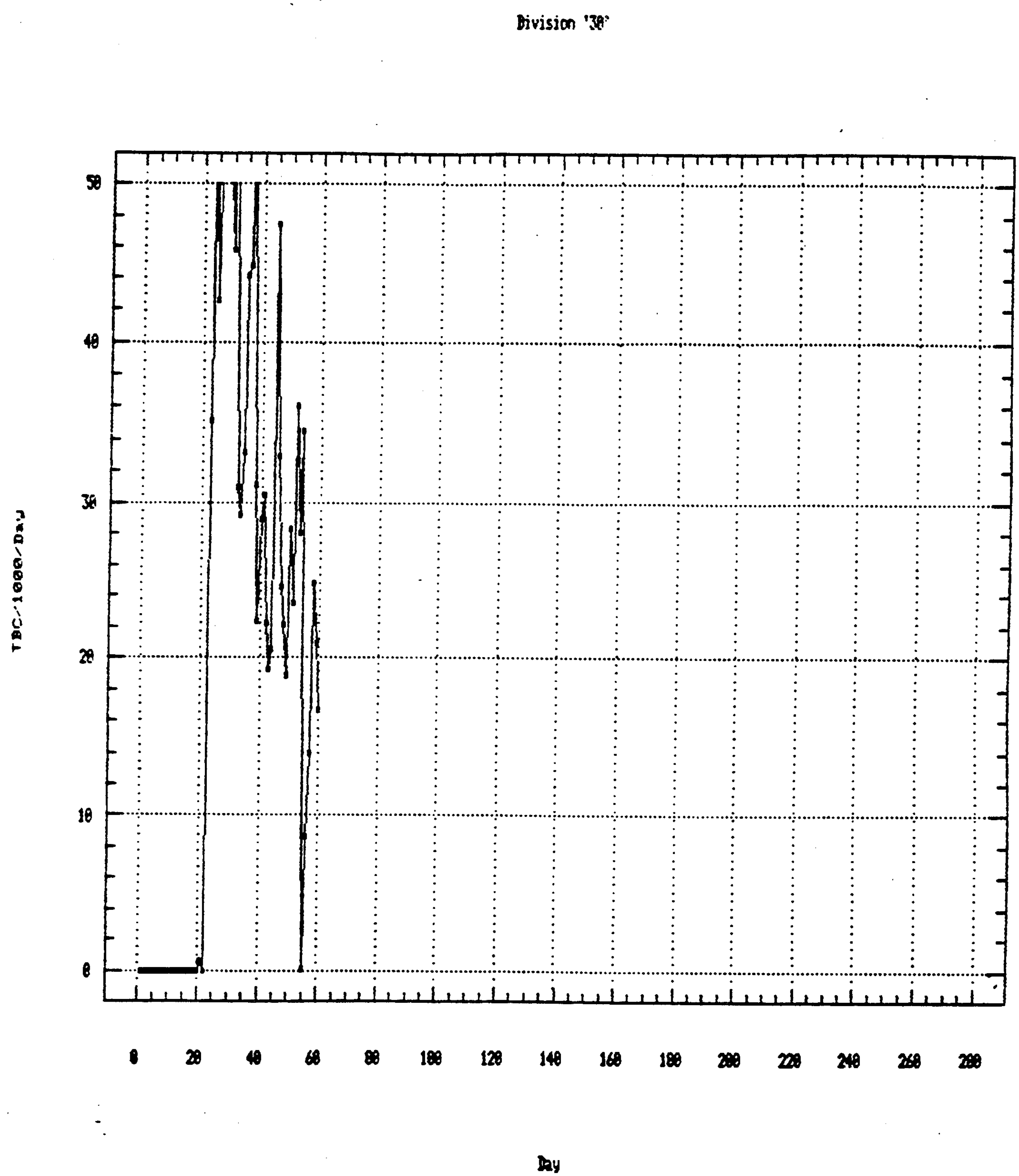
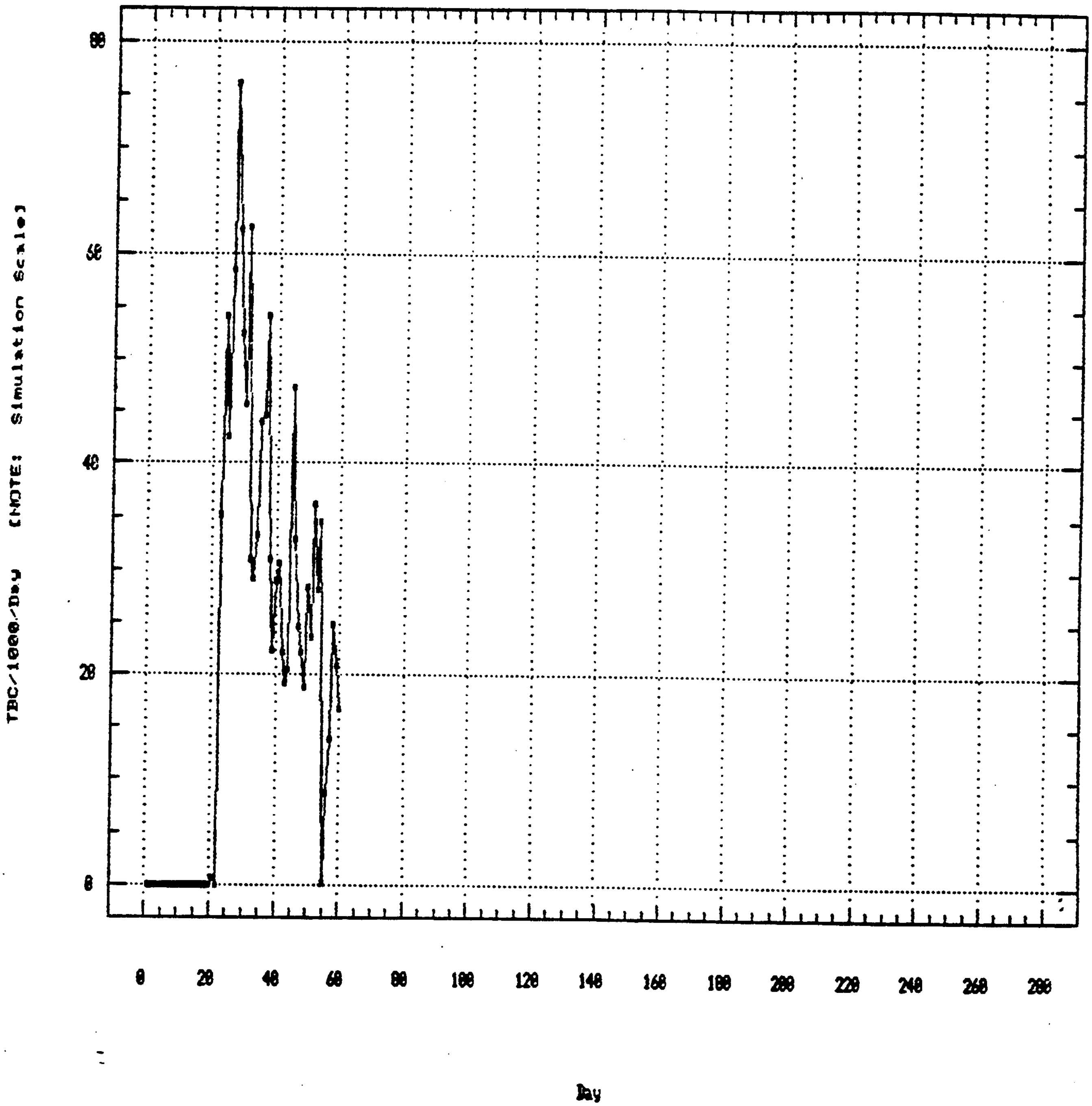
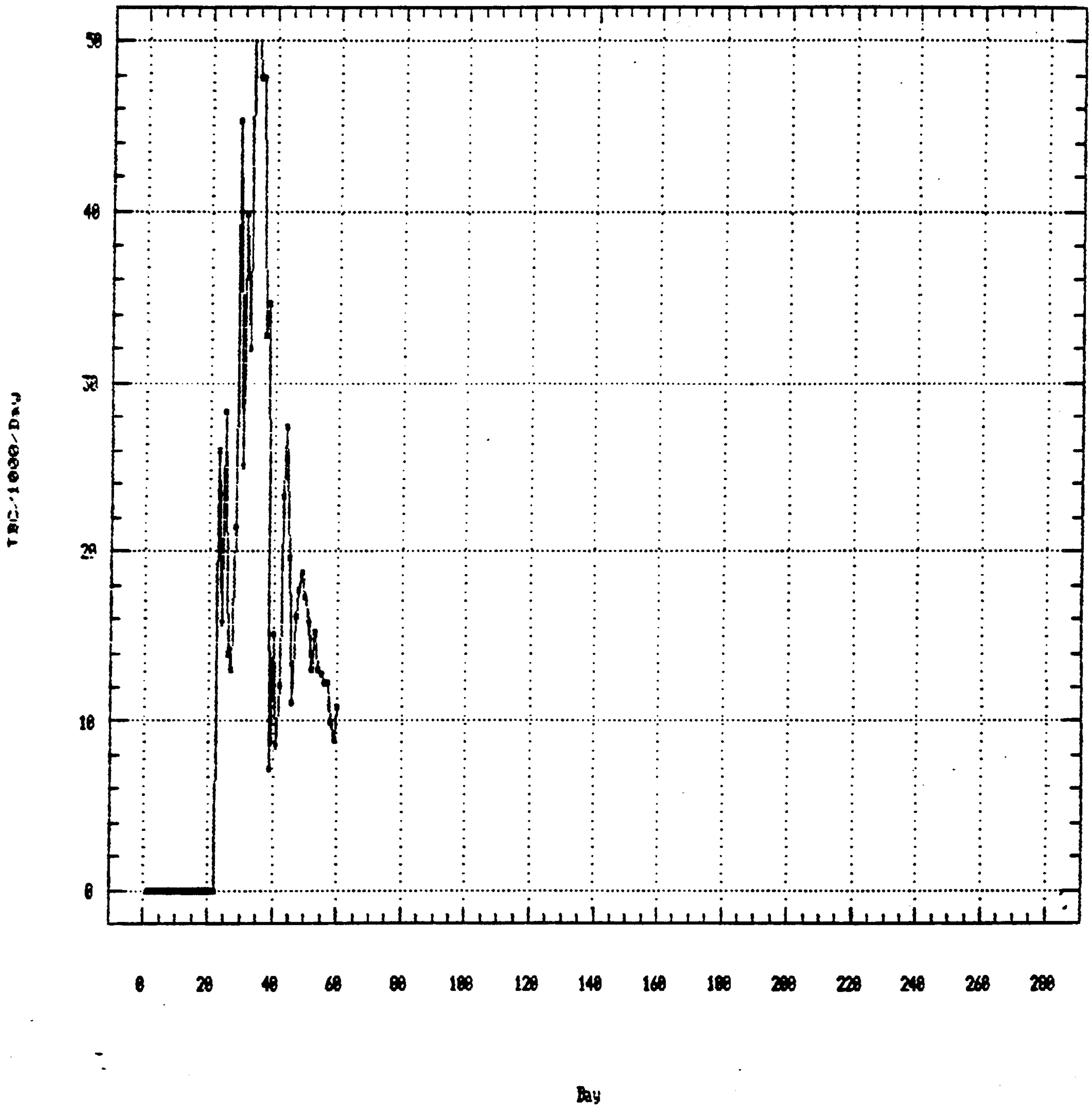
220
240
260
280
Day


Division '30'
TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '30'


TBC/1000/Day [NOTE: Simulation Scale]
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '33'



50
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10
0
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40
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80
100
120
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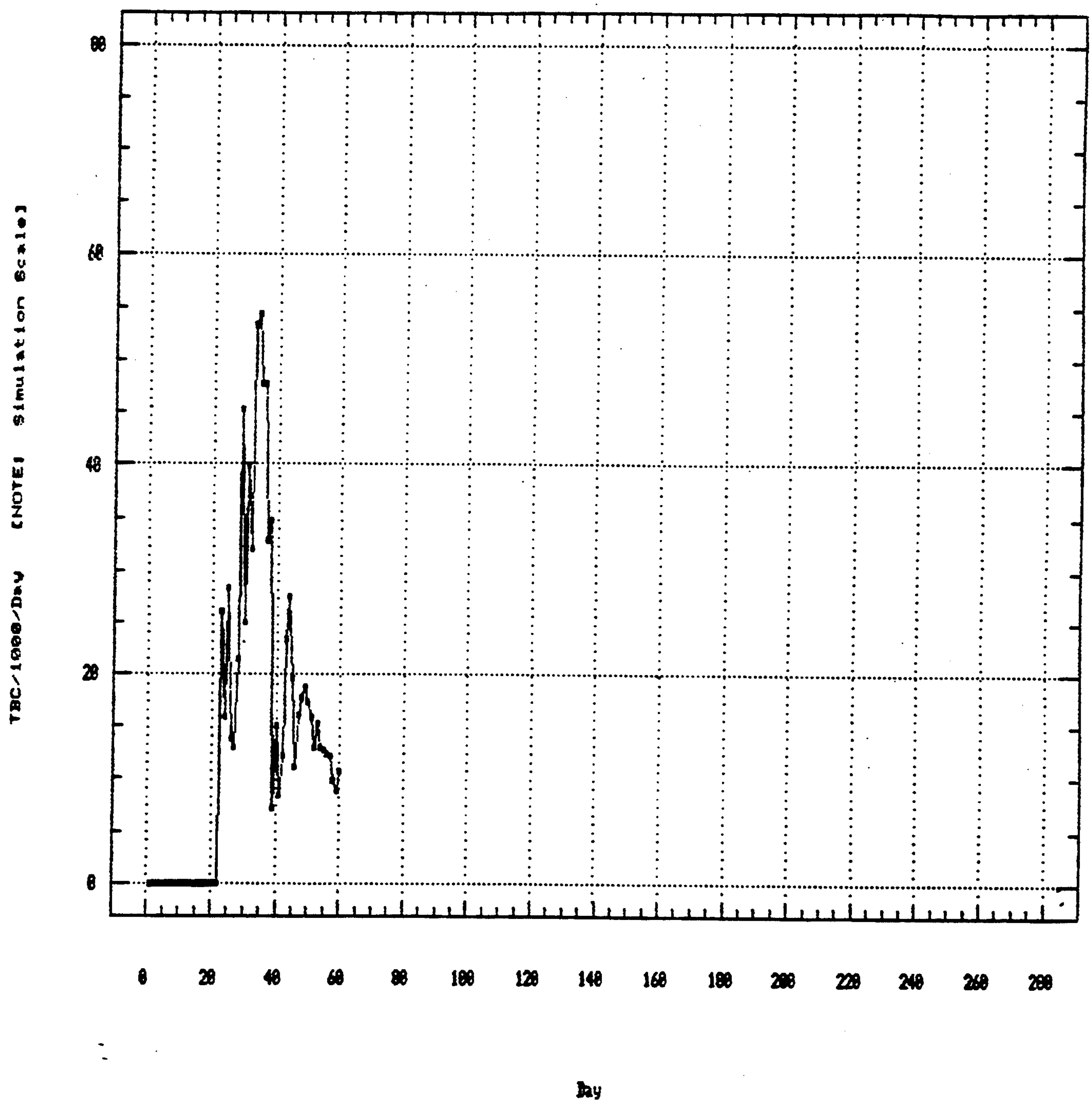
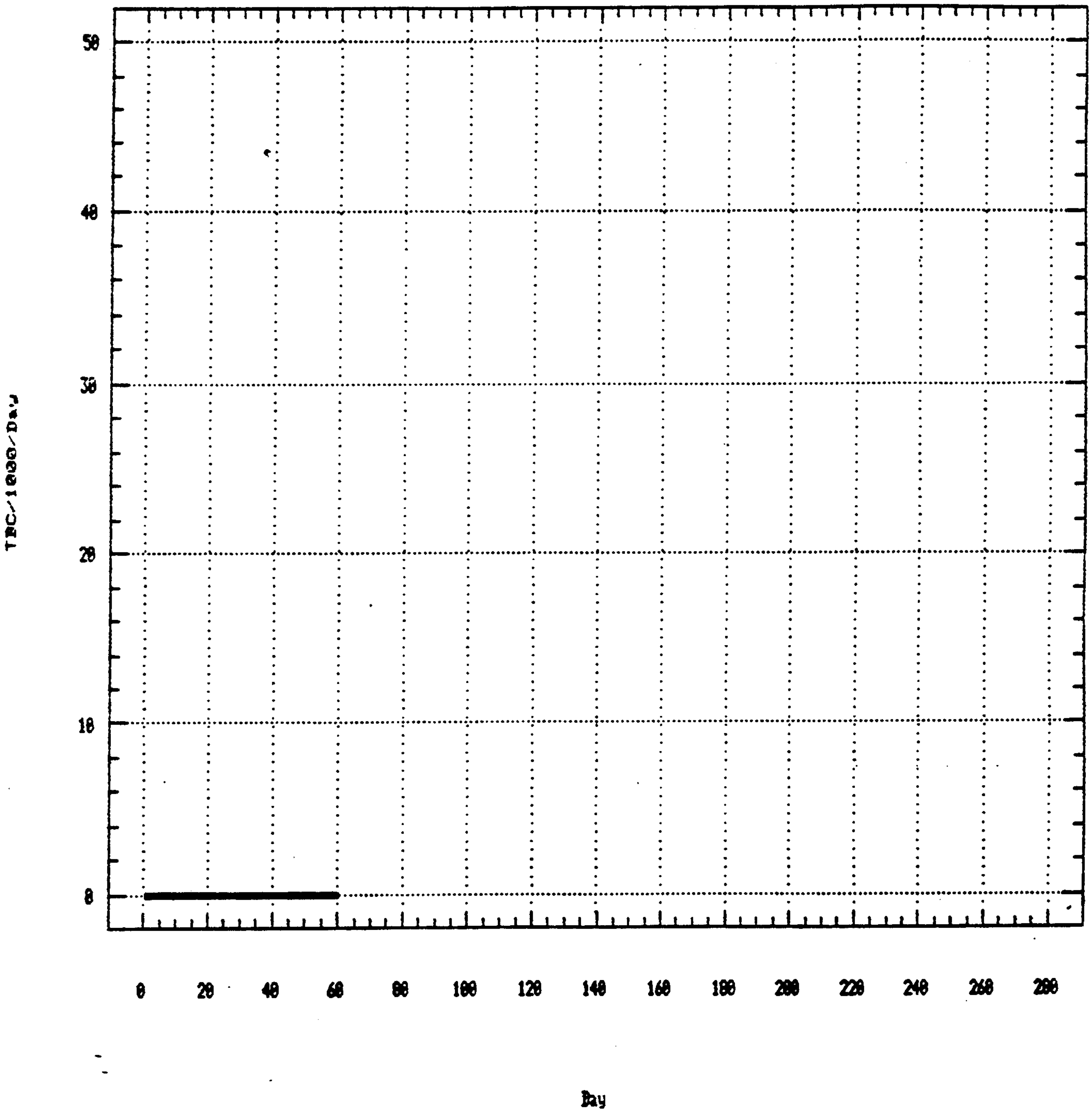
180
200
220
240
260
280
Day

Division '33'


TBC/1000/Day [NOTE: Simulation Scale]
0
20
40
60
80
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '34'



TBC/1000/Day
50
40
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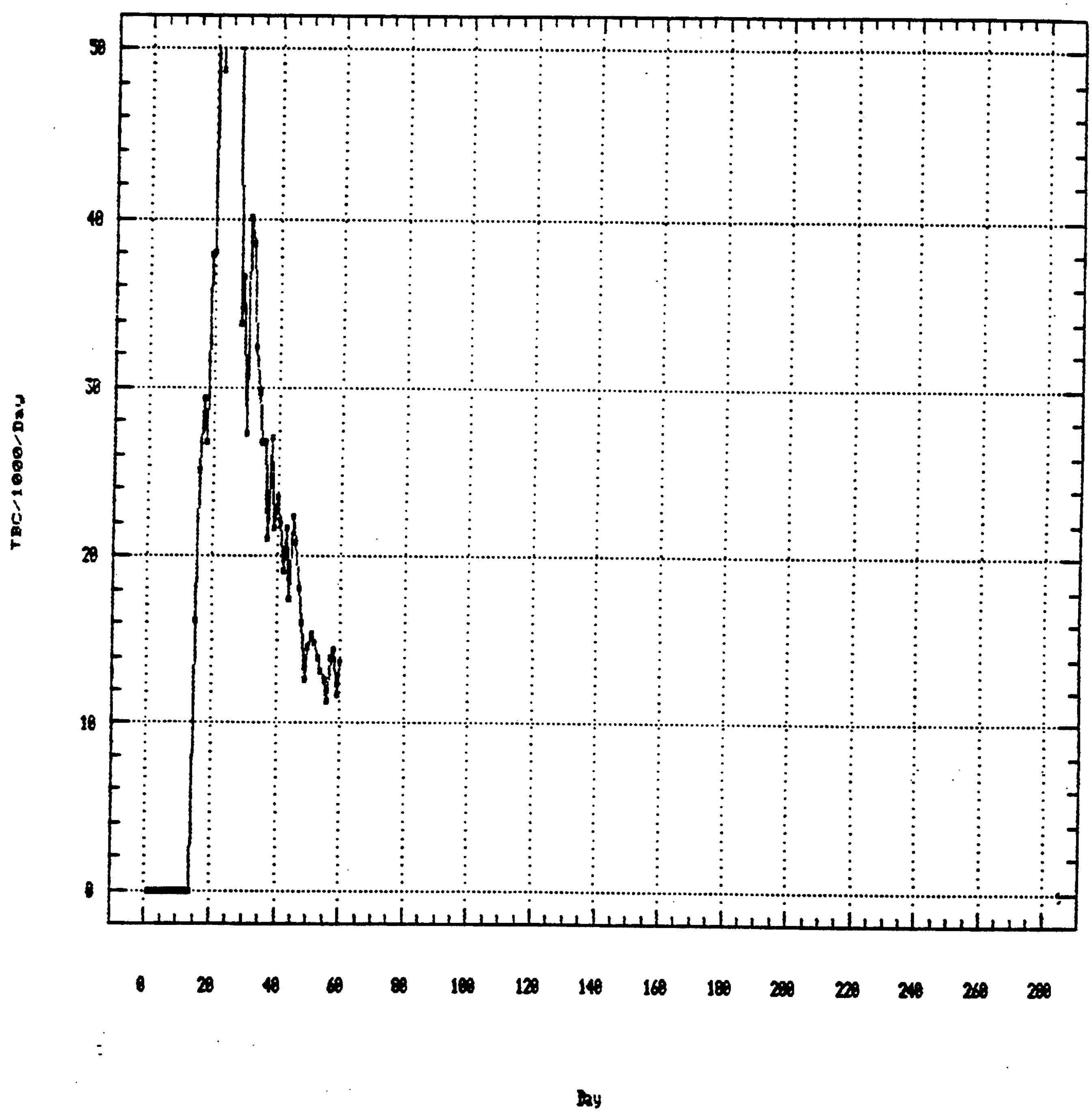
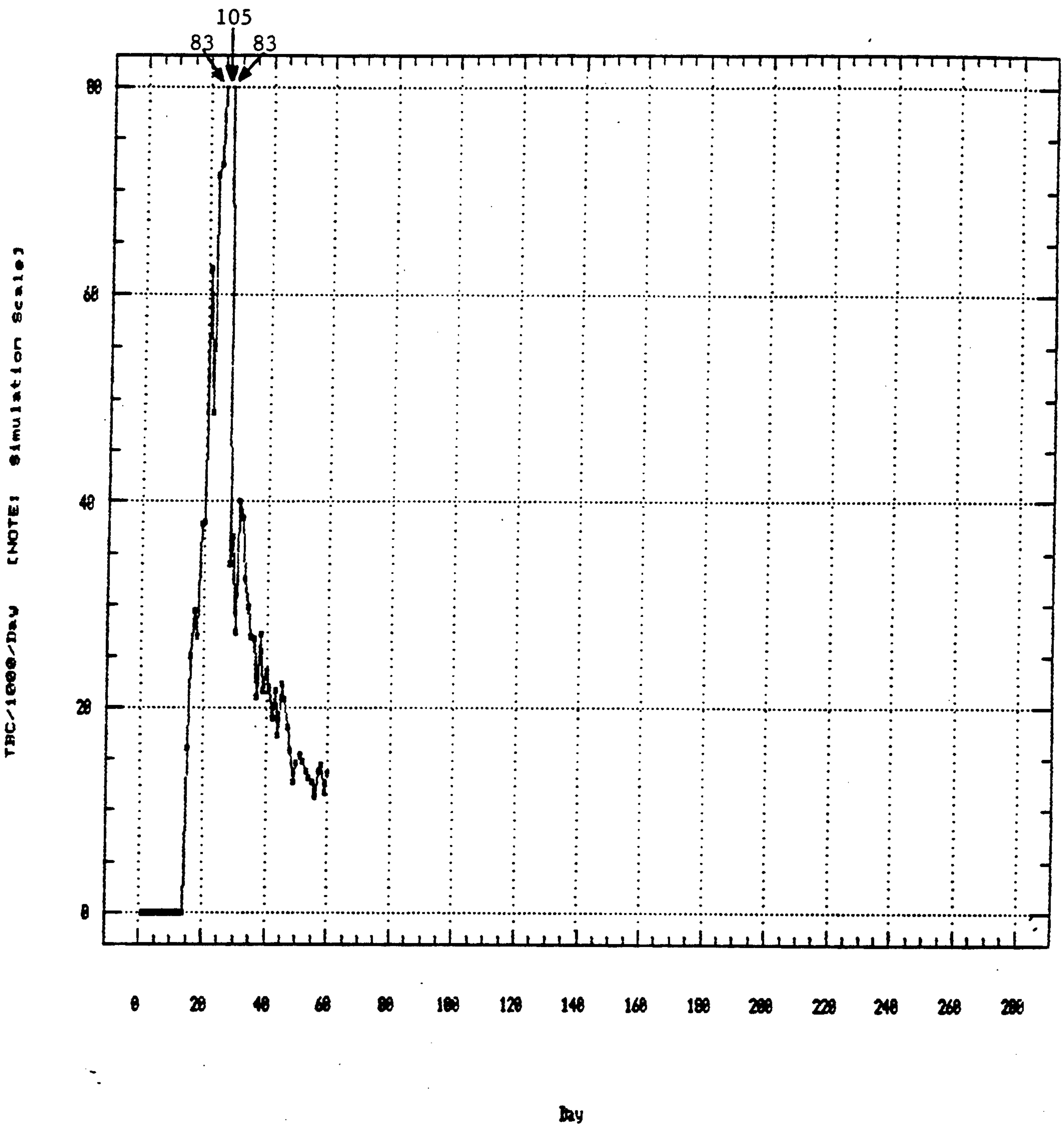
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '35'

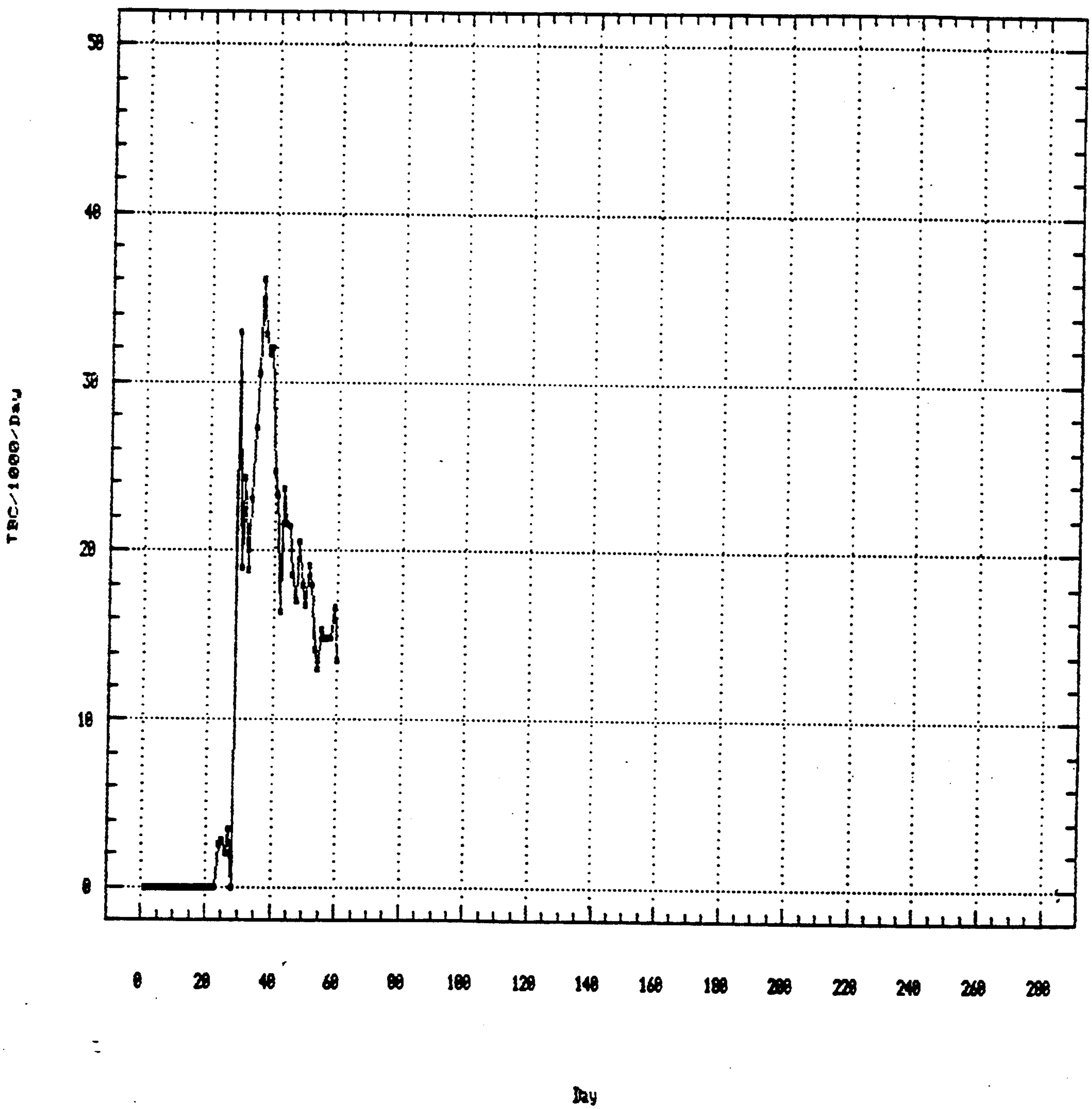

50
40
30
20
10
0
TBC/1000/Day
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '35'



105
83
83
80
60
40
20
0
TBC/1000/Day [NOTE: Simulation Scale]
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '36'



50
40
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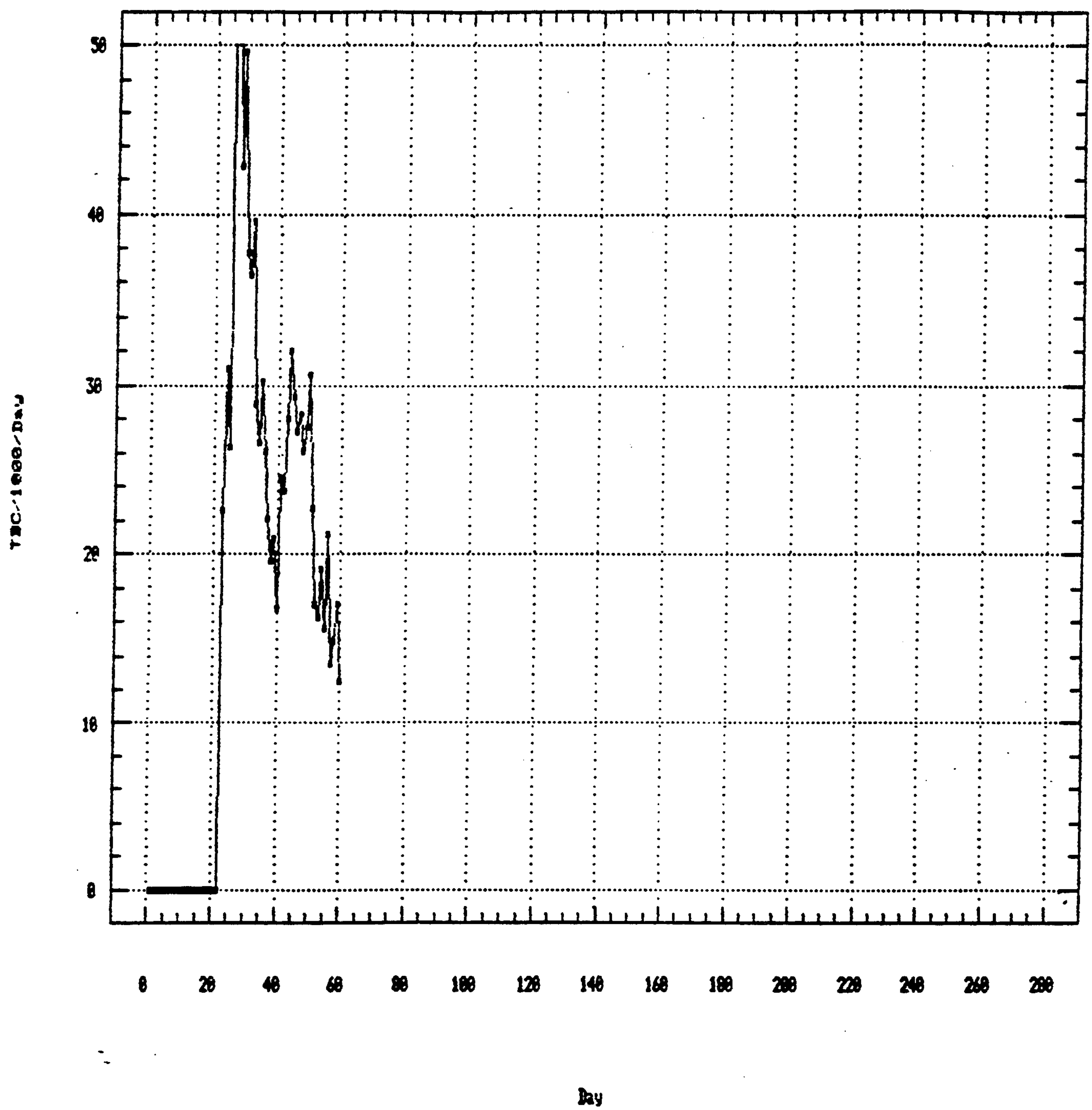
10
0
TRC/1000/Day
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '37'



50
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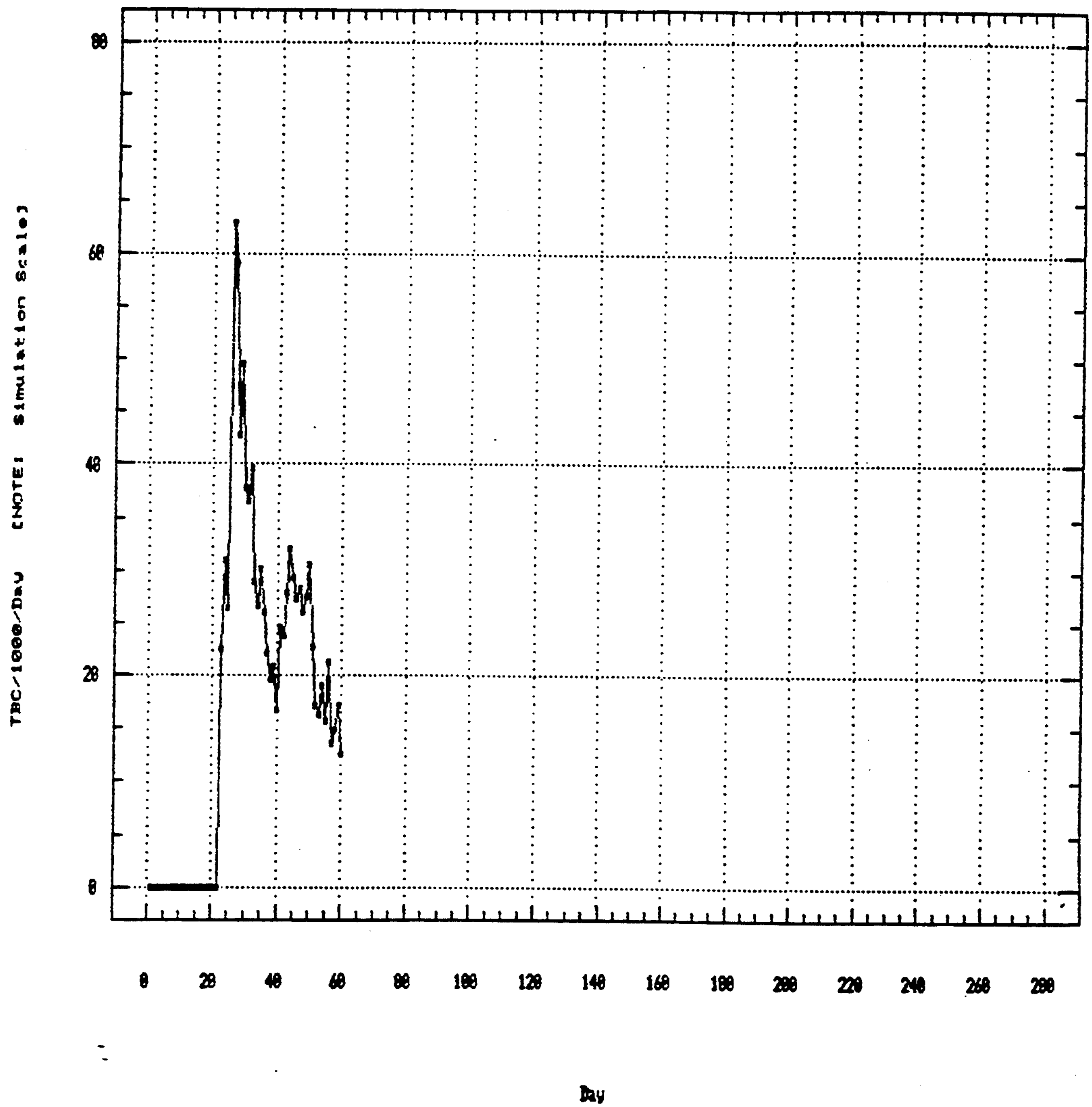
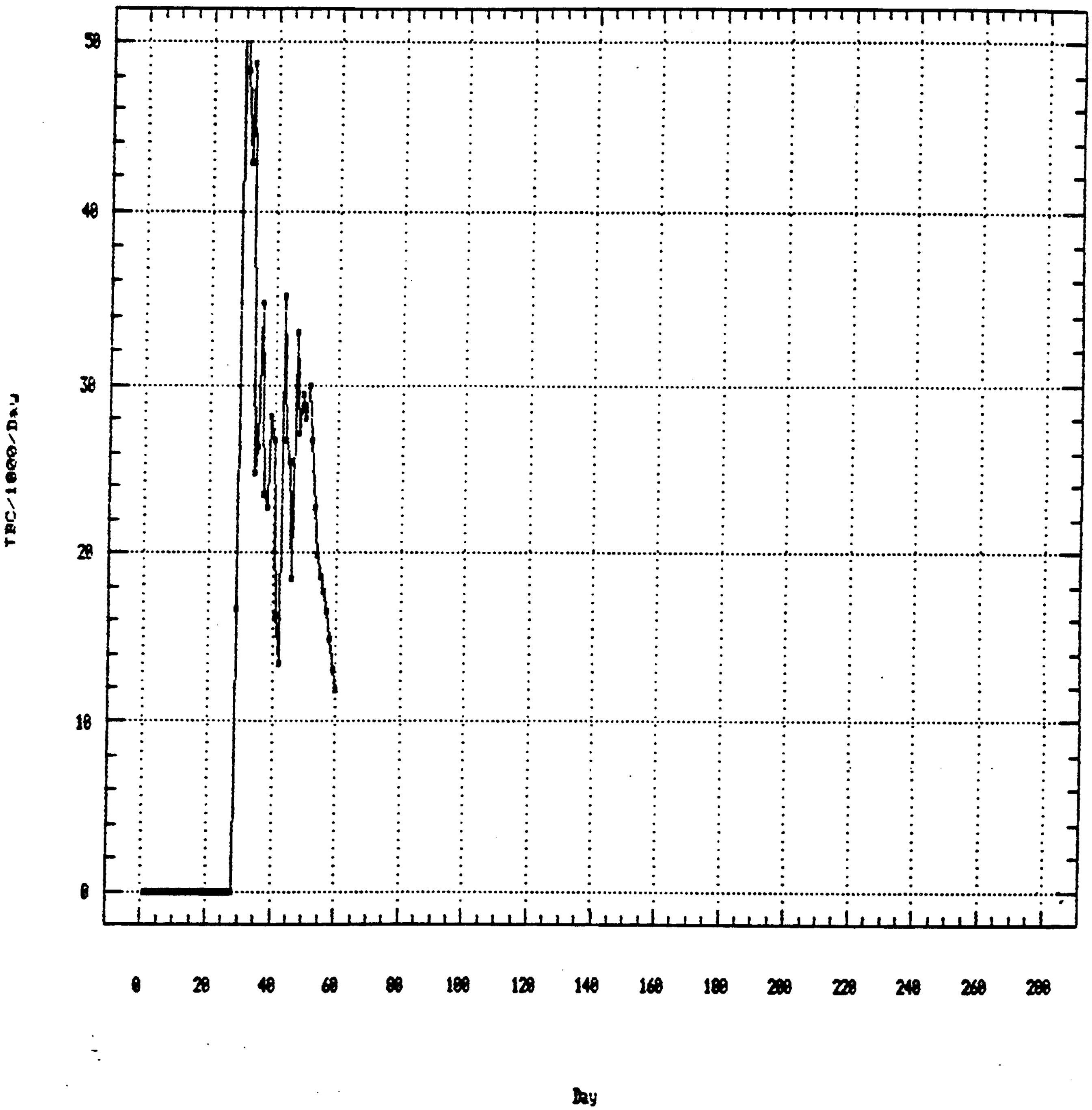
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day
TBC/1000/Day

Division '37'



80
60
40
20
0
TBC/1000/Day (NOTE: Simulation Scale)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '39'


TBC/1000/Day
50
40
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20
10
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0
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40
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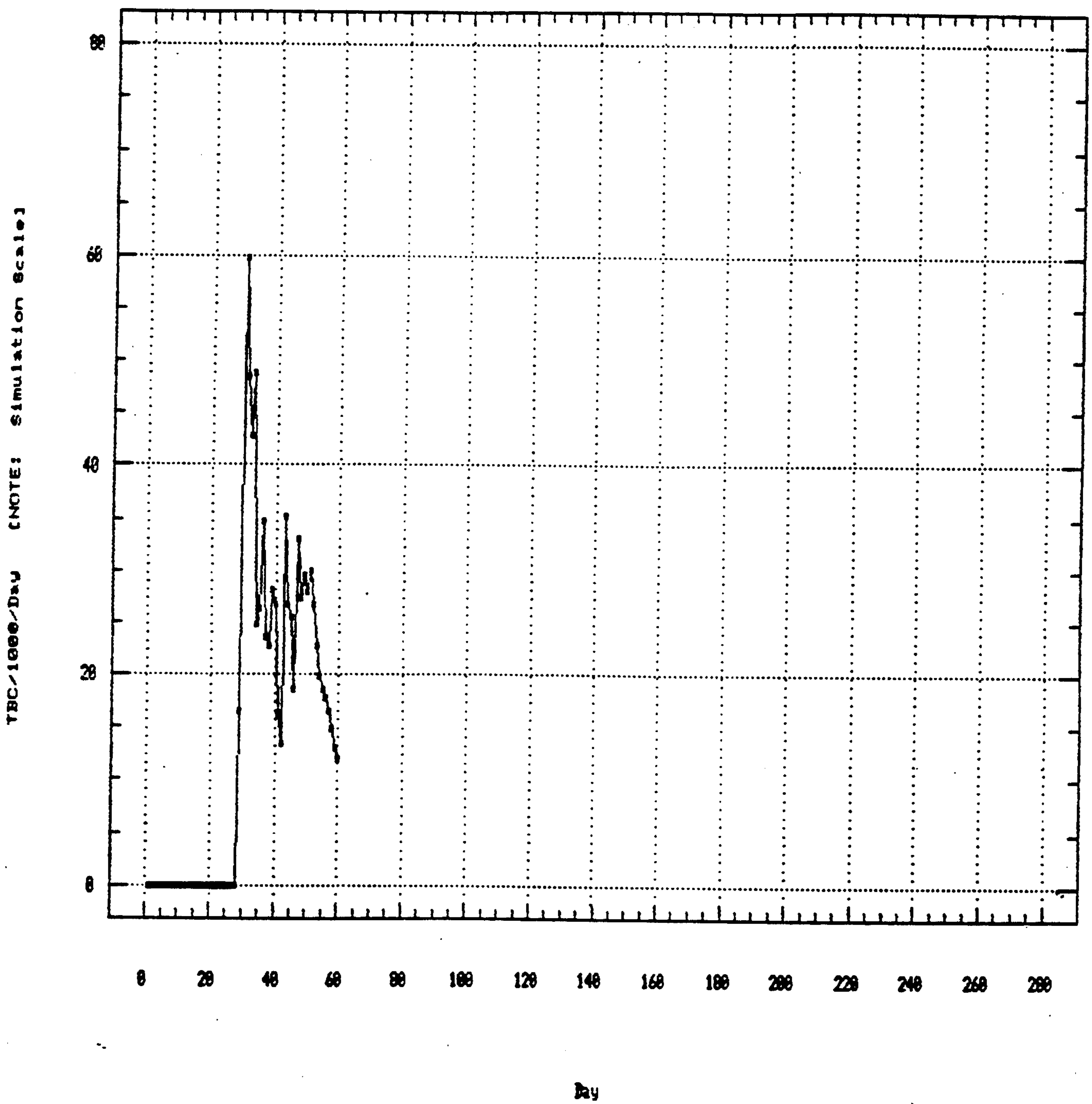
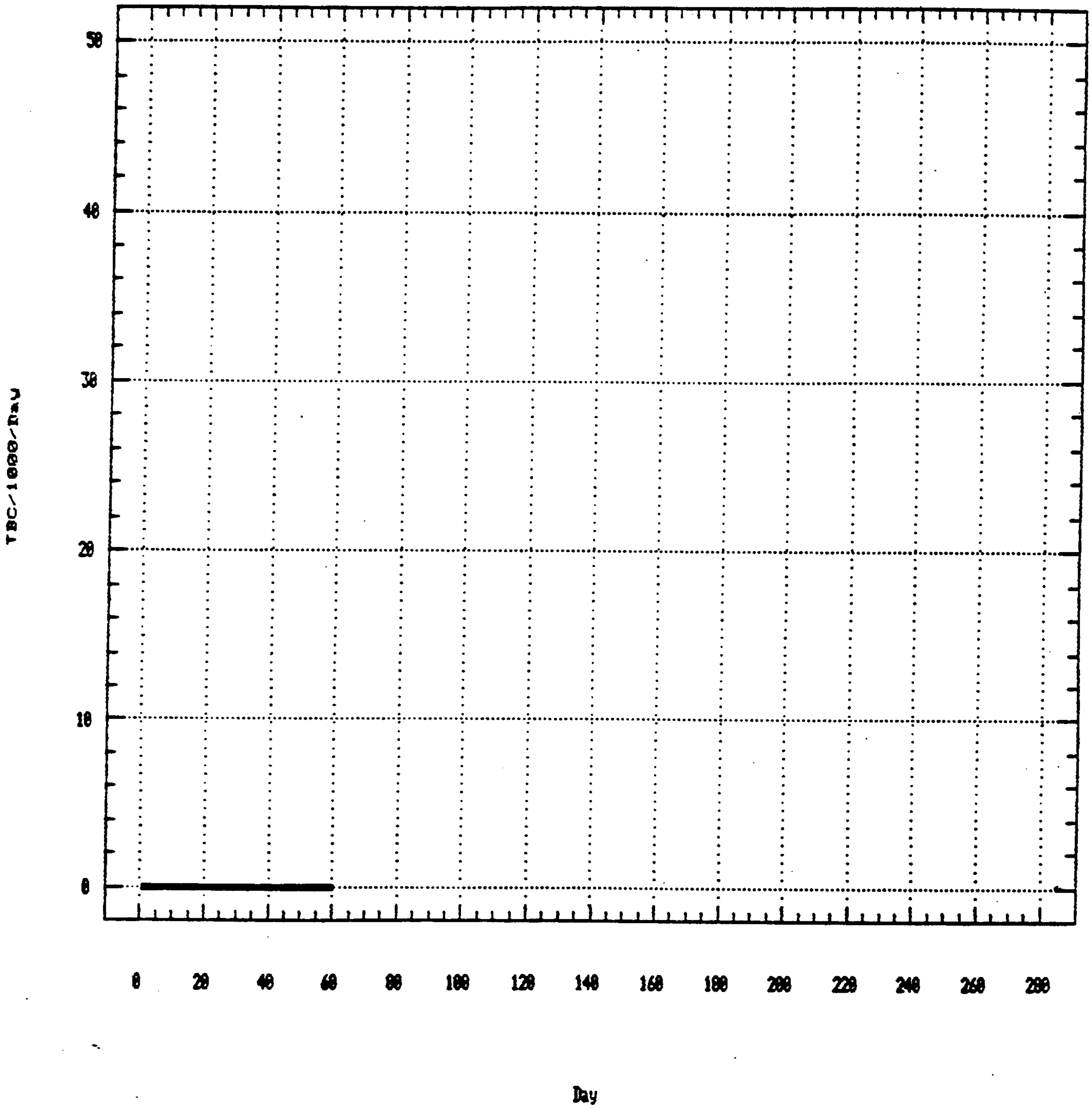
80
100
120
140
160
180
200
220
240
260
280
Day

Division '39'



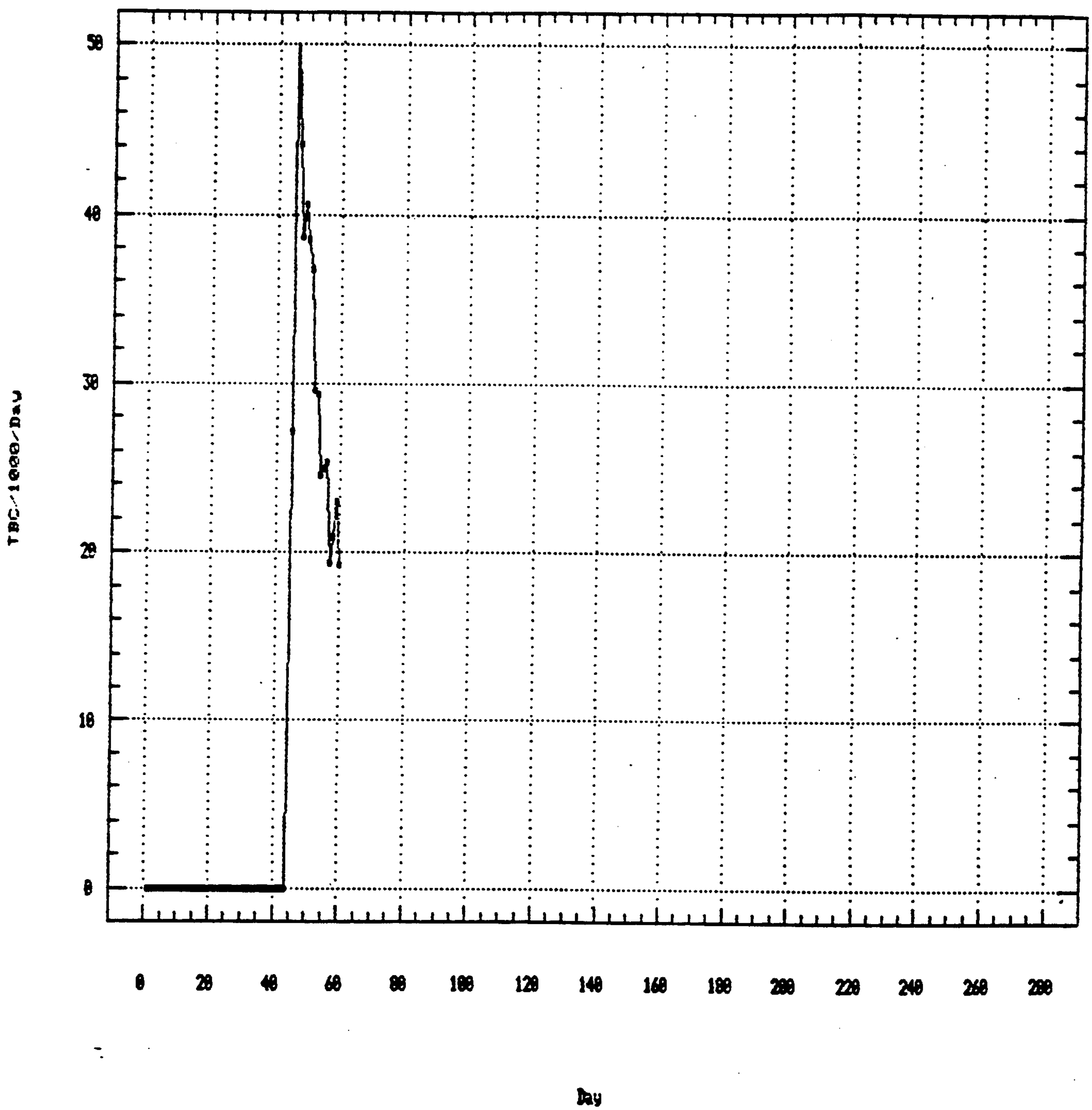
TBC/1000/Day (NOTE: Simulation Scale)
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '44'



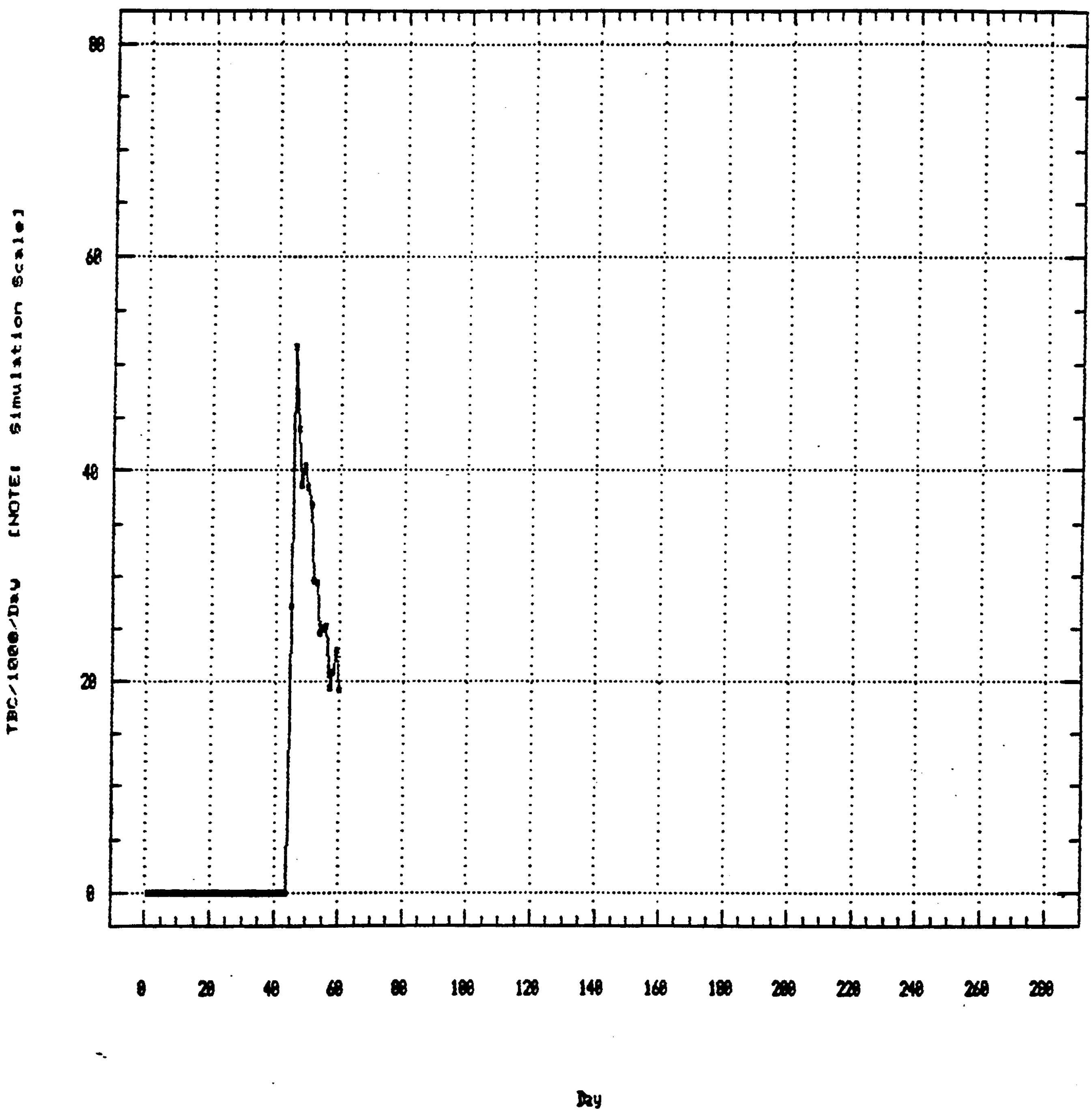
50
40
30
20
10
0
TBC/1000/Day
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '45'



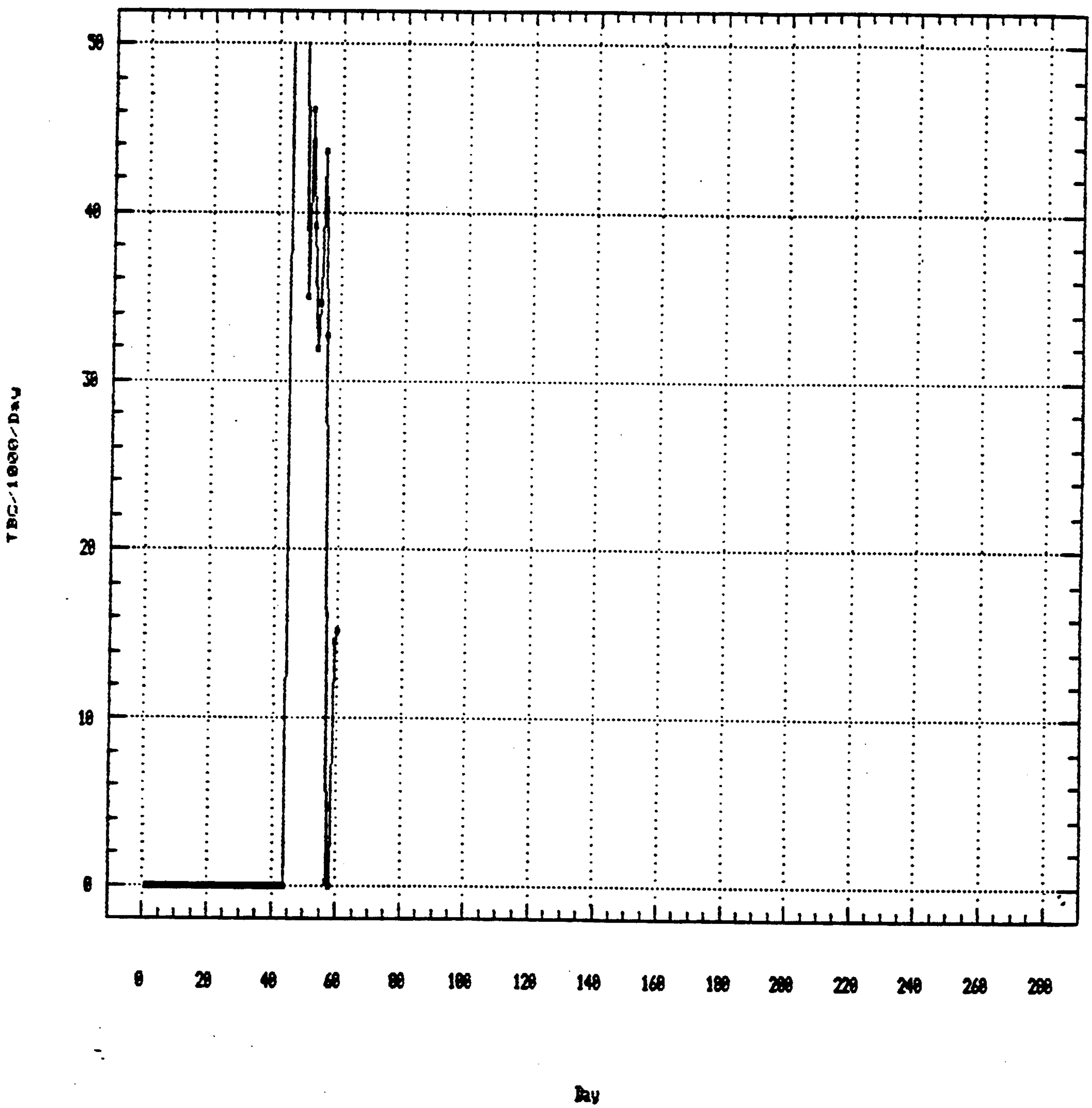
TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '45'



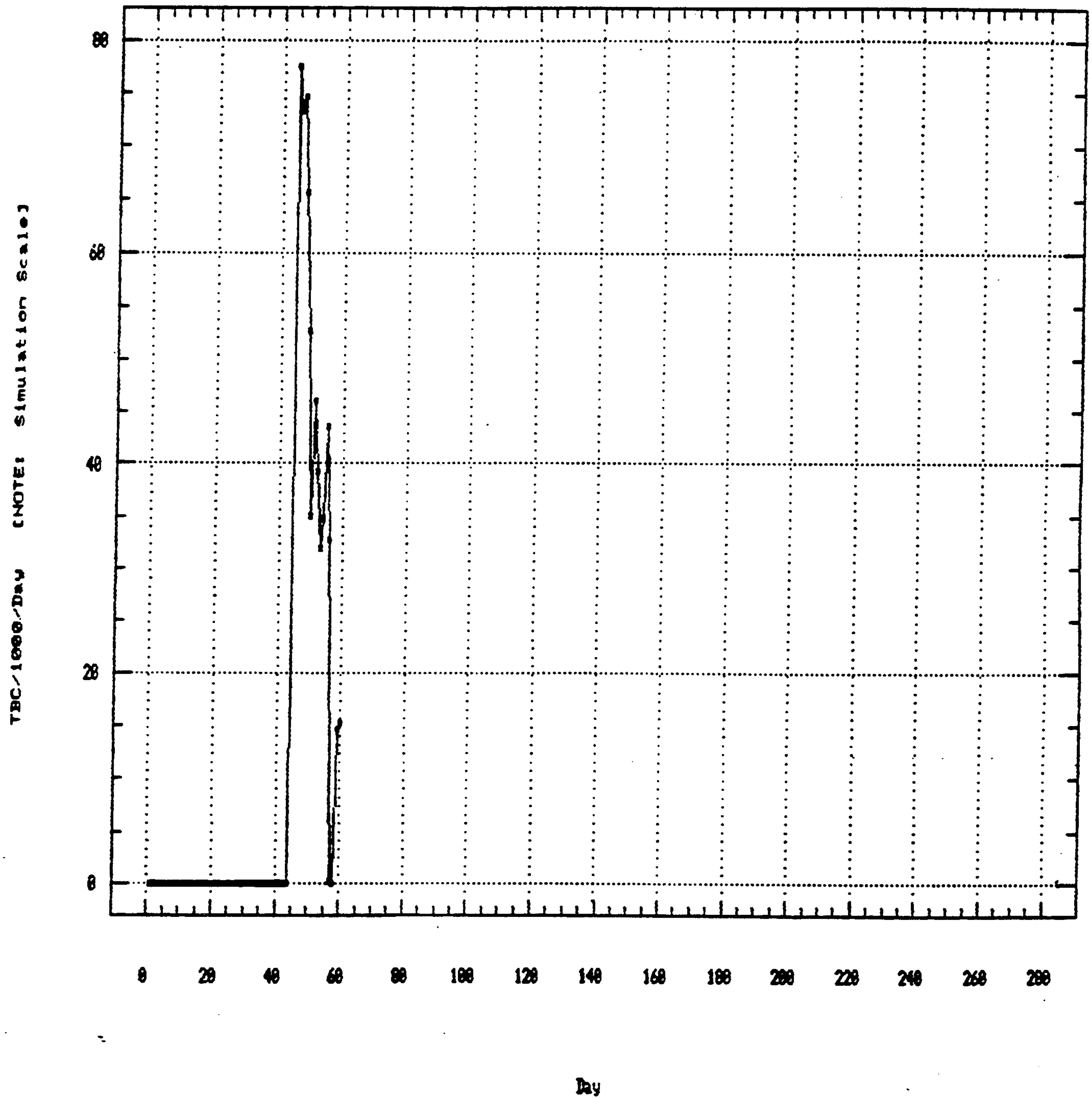
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
TBC/1000/Day [NOTE: Simulation Scale]
Day

Division '47'



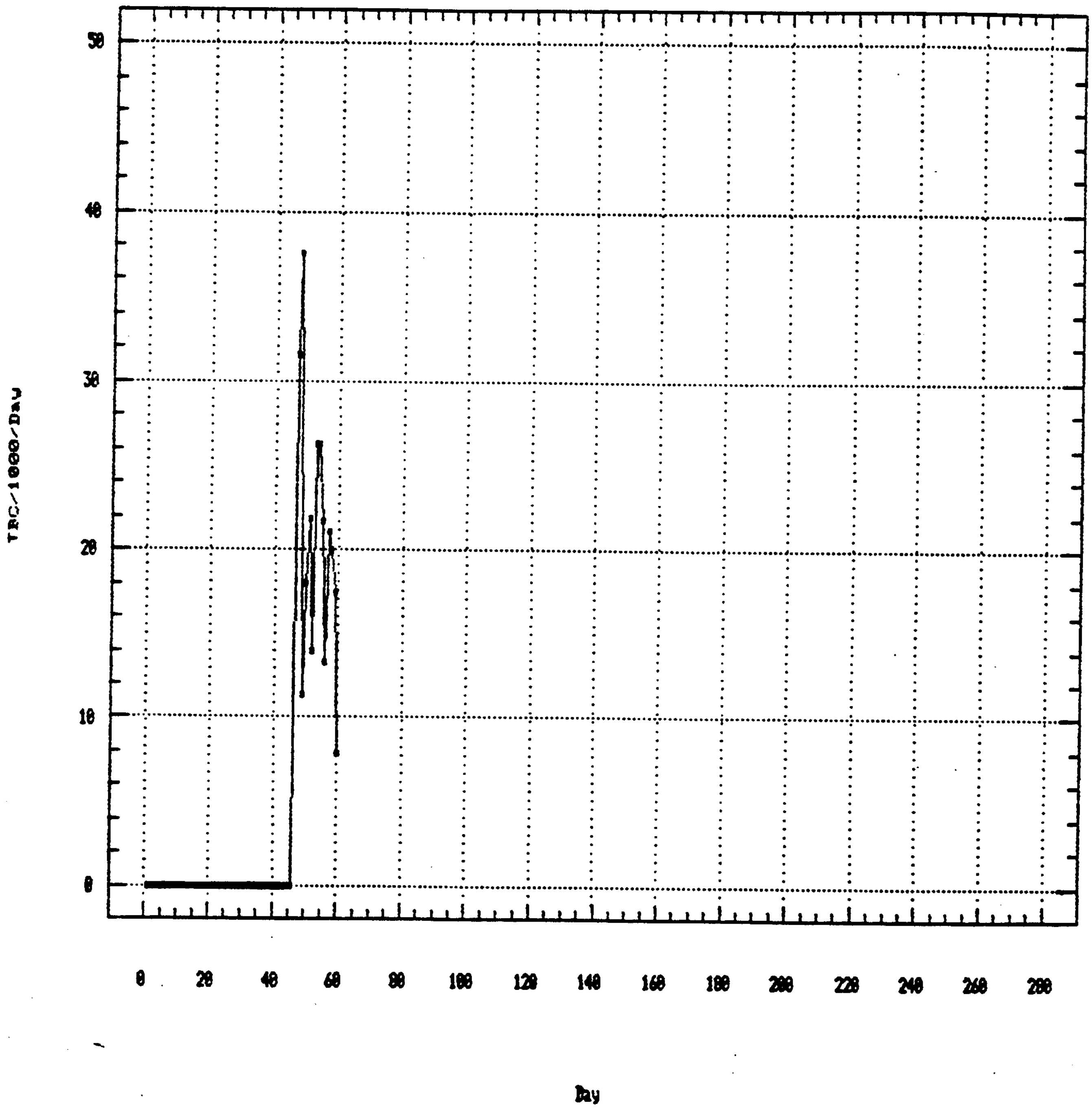
TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '47'



TBC/1000/Day (NOTE: Simulation Scale)
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '49'



50
40
30
20
10
0
TRC/1000/Day
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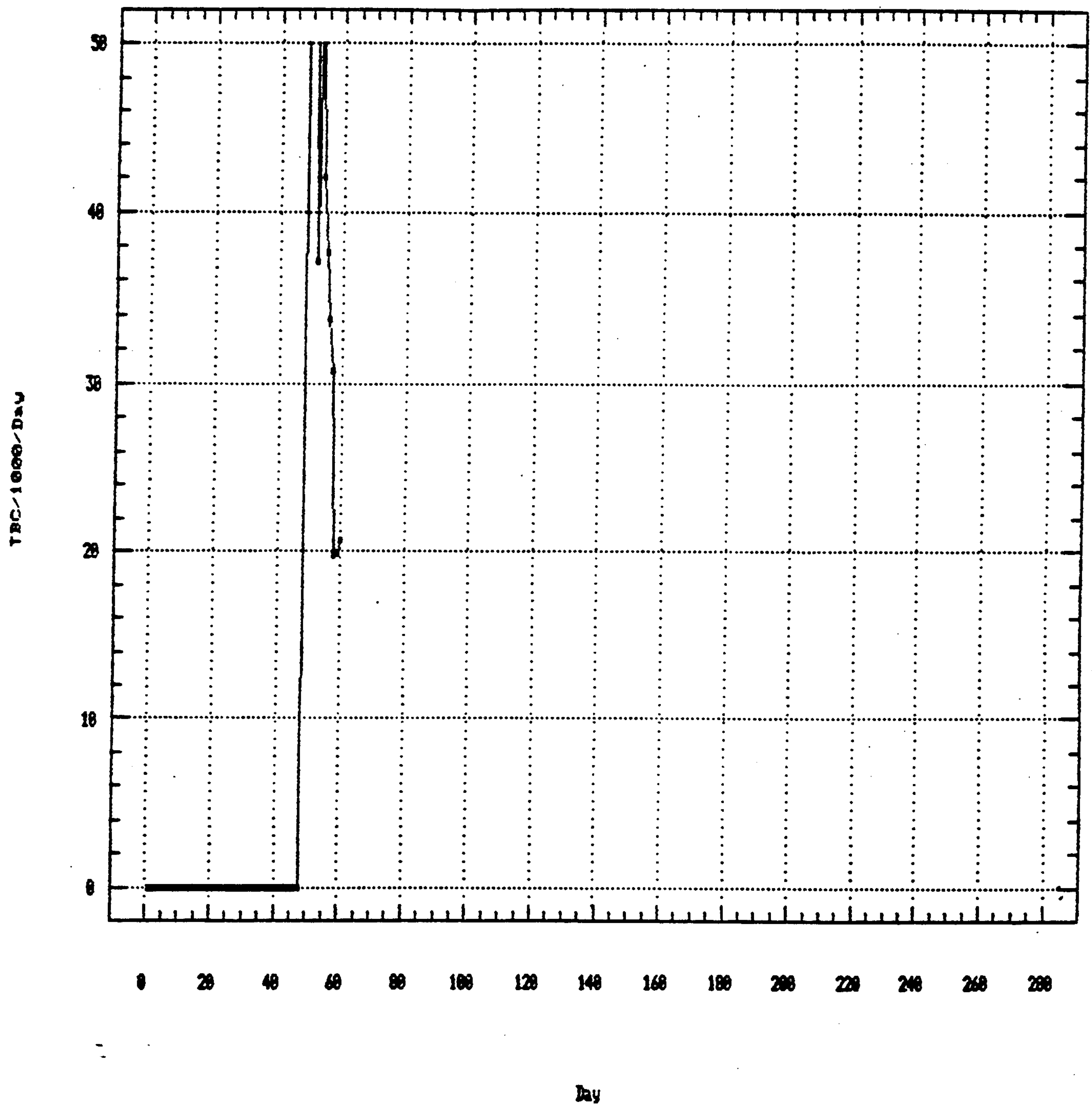
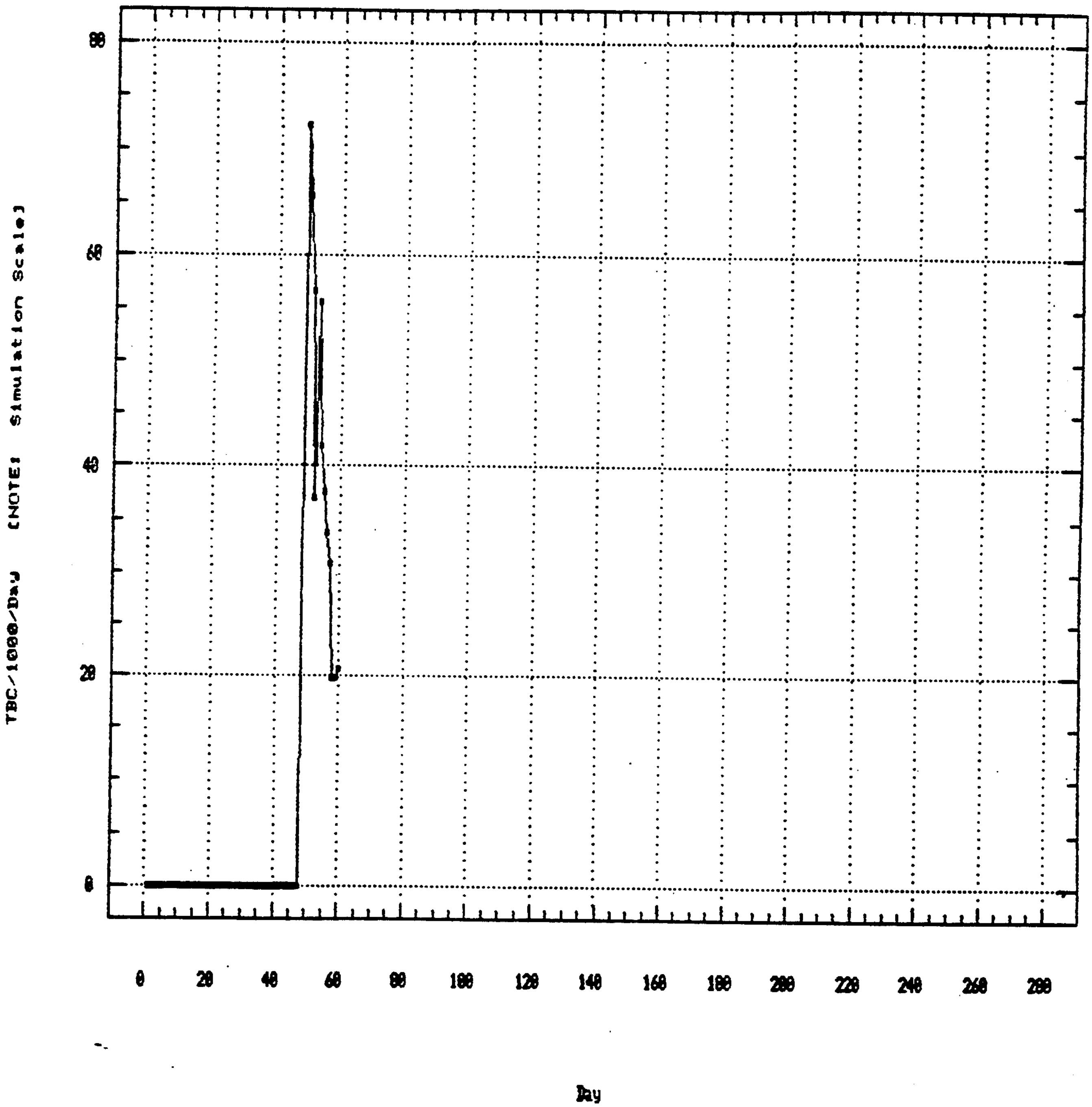
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '58'



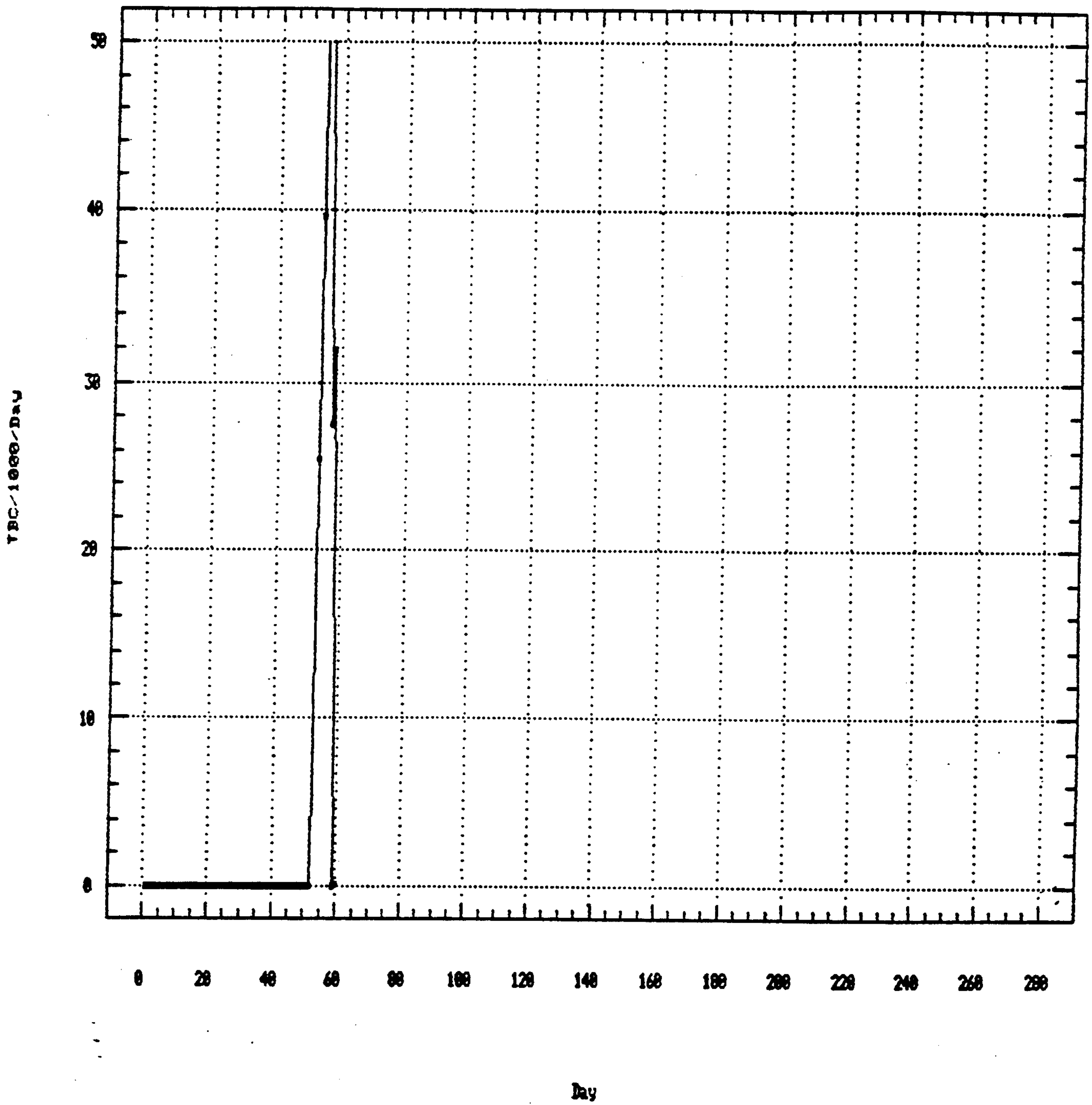
50
40
30
20
10
0
TBC/1000/Day
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '50'



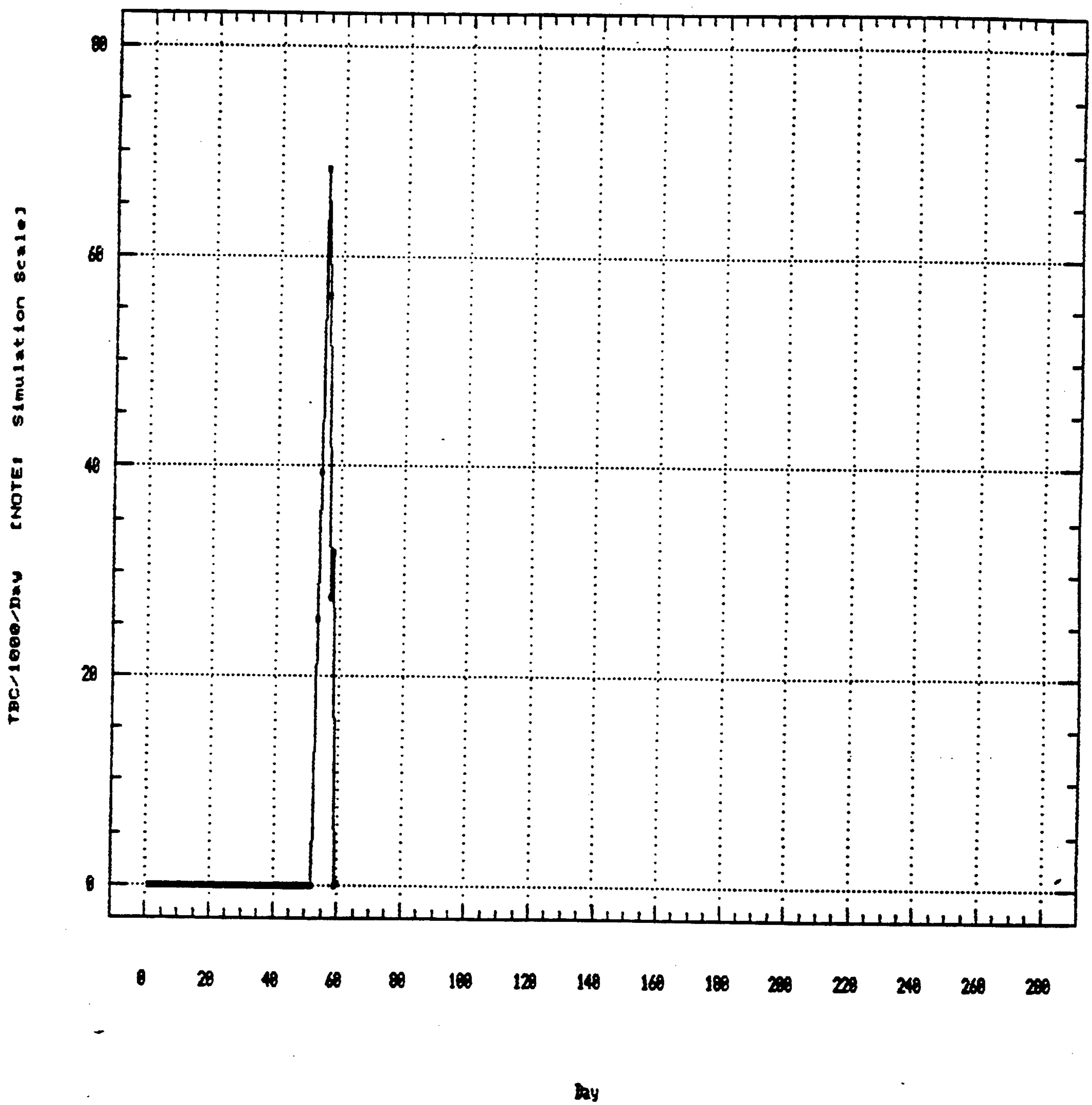
TBC/1000/Day (NOTE: Simulation Scale)
80
60
40
20
0
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280
Day

Division '51'

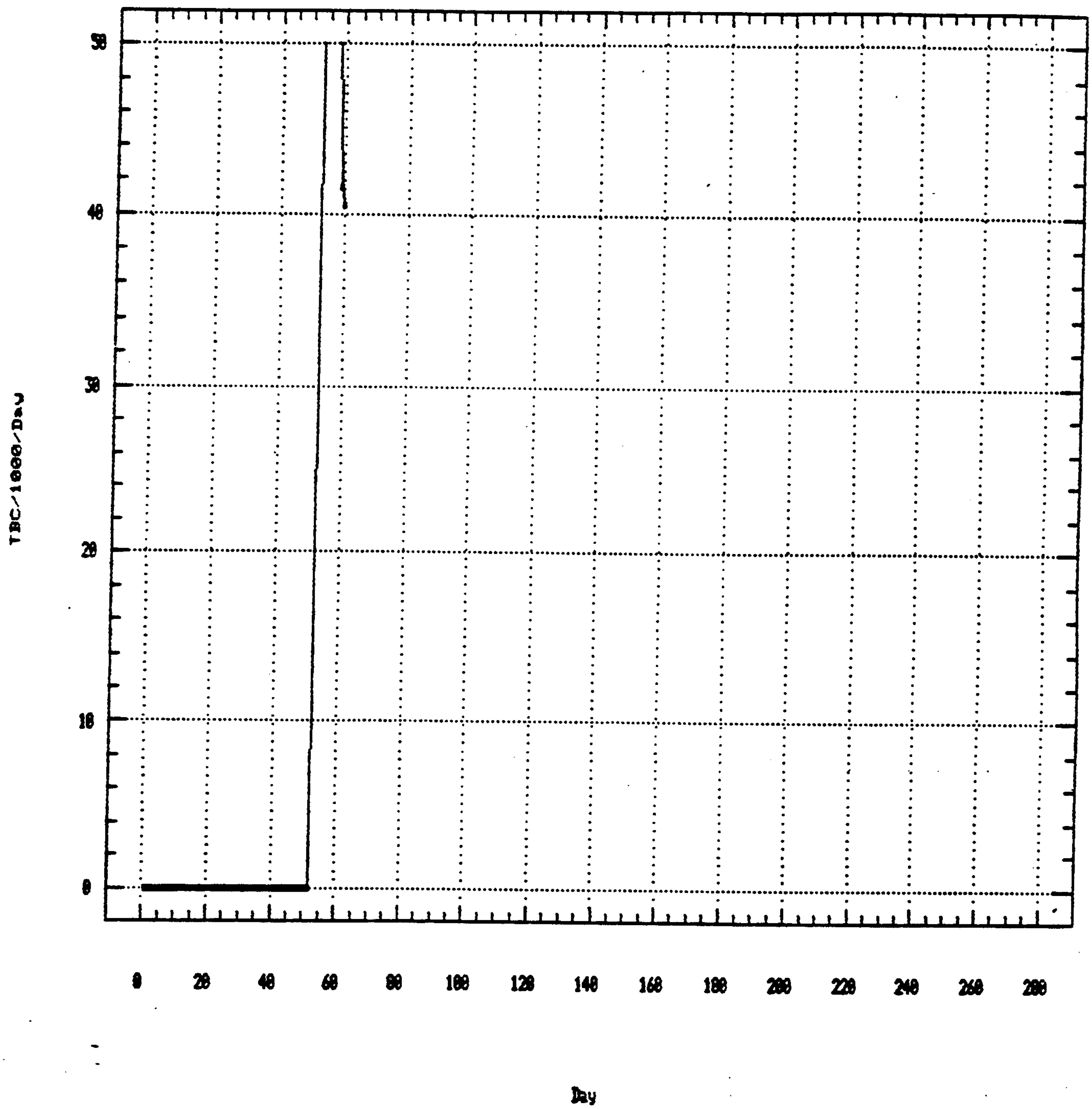


50
40
30
20
10
0
TBC/1000/Day
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '51'

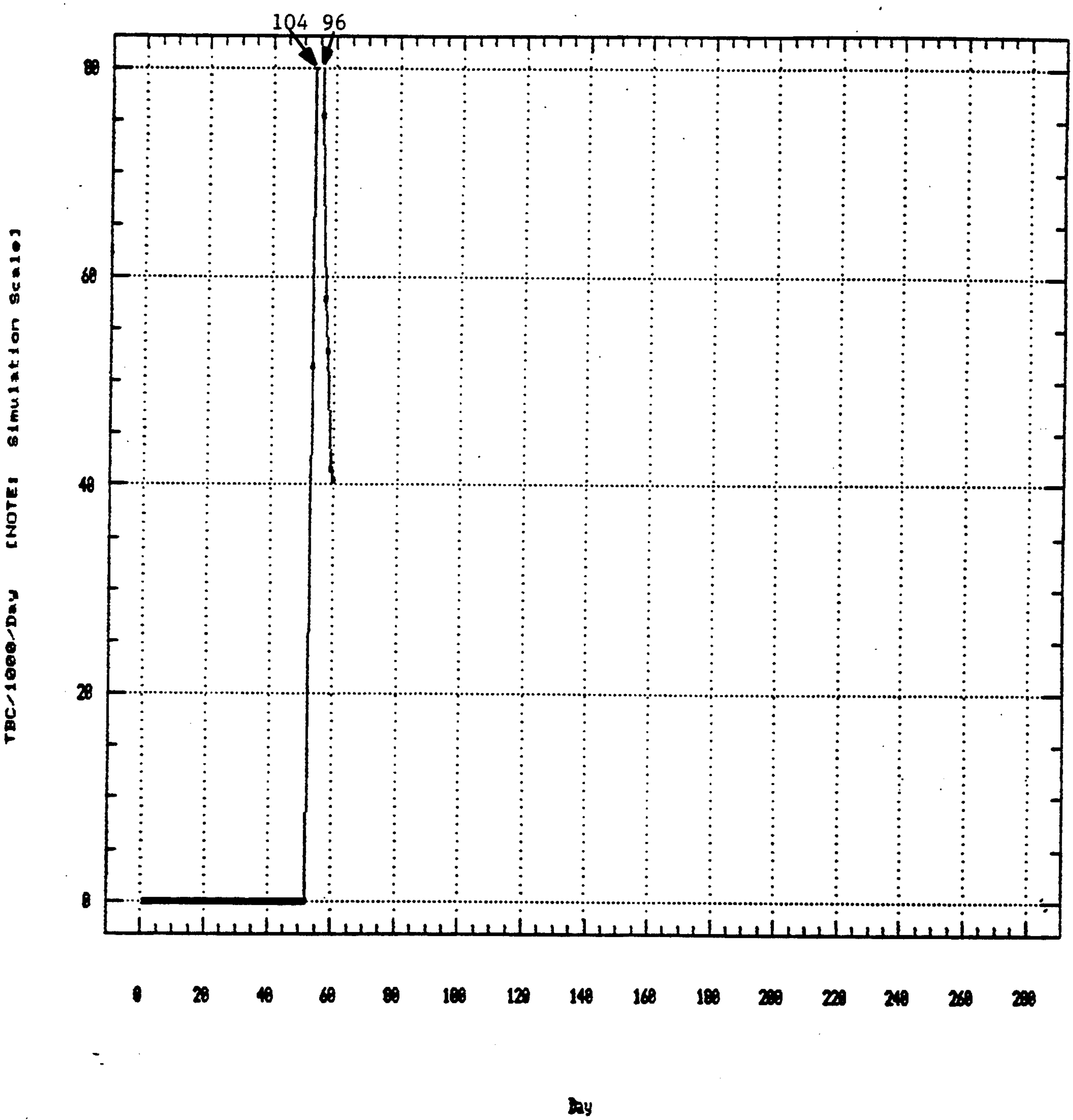

80
60
40
20
0
TBC/1000/Day [NOTE: Simulation Scale]
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '52'

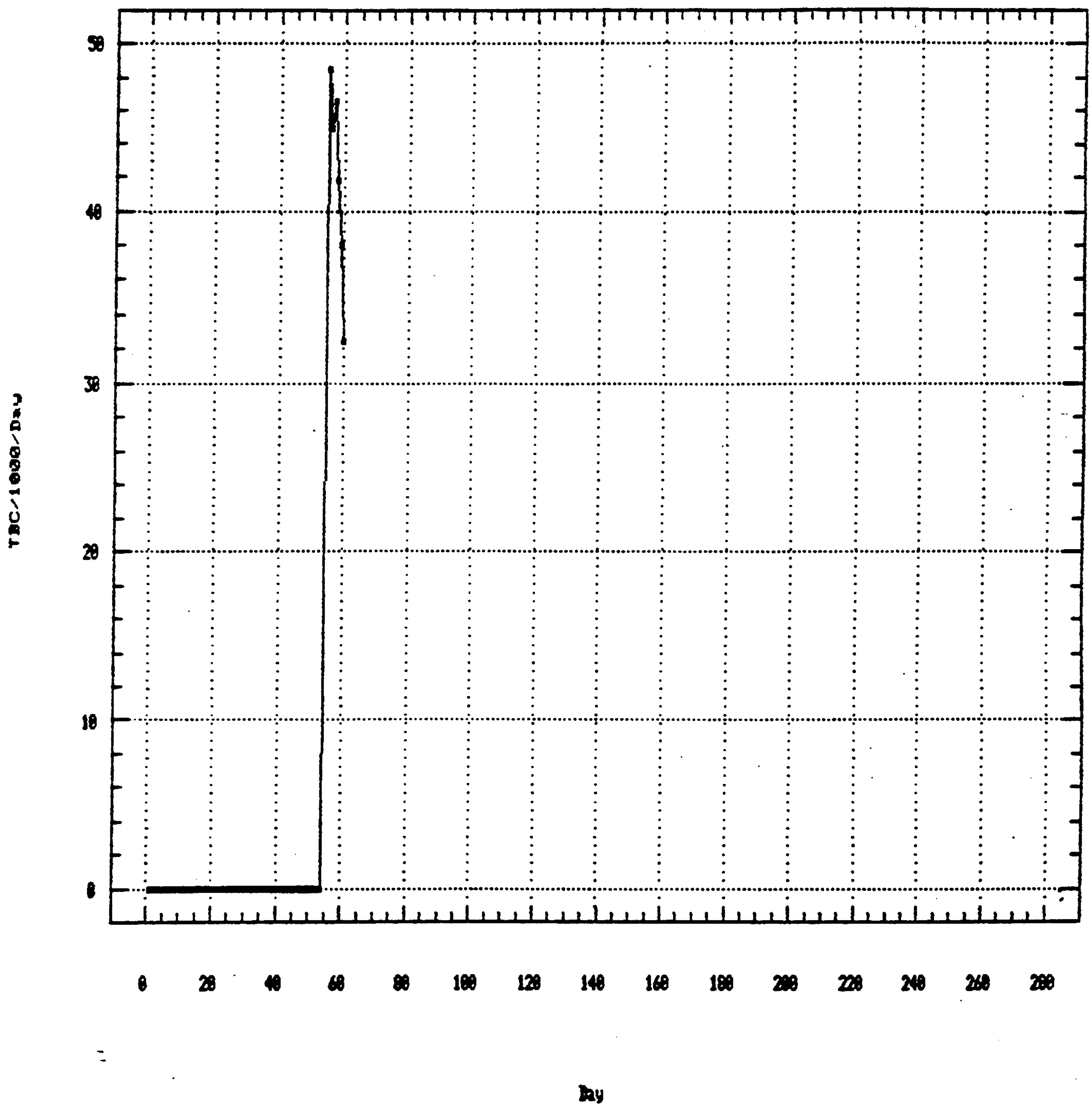


TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division "52"

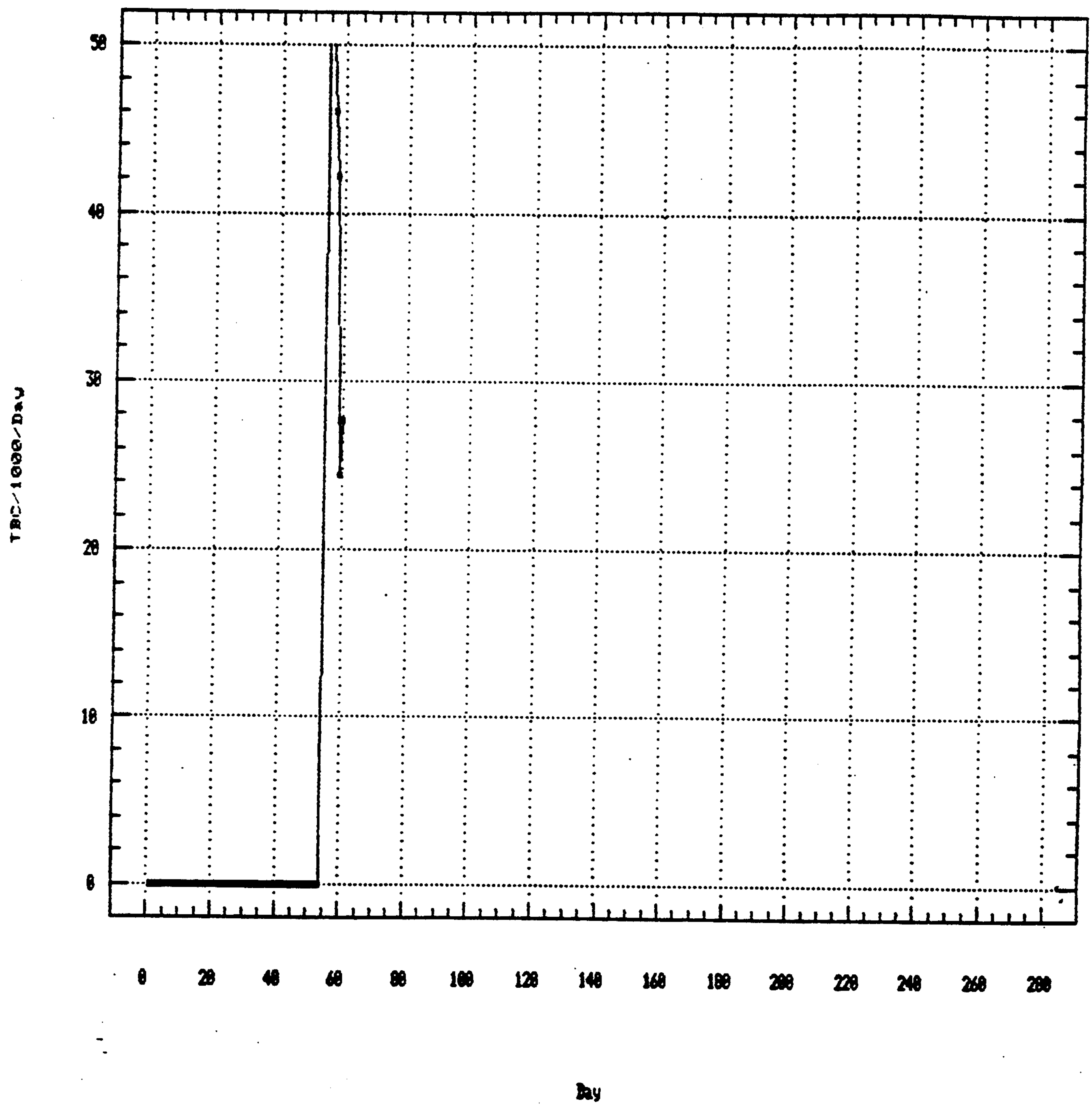

104 96
80
60
40
20
0
TBC/1000/Day [NOTE: Simulation Scale]
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '53'



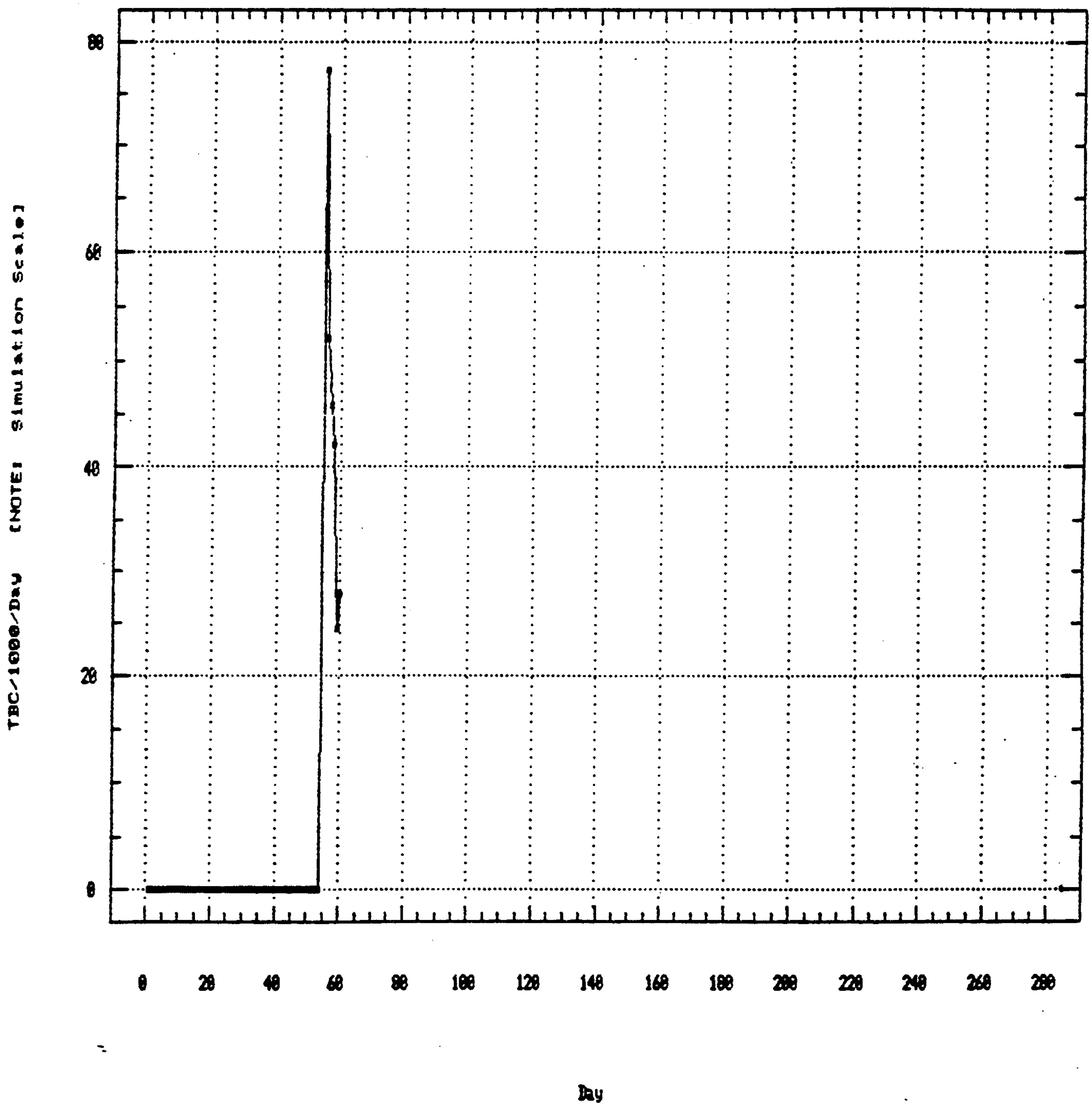
TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '54'



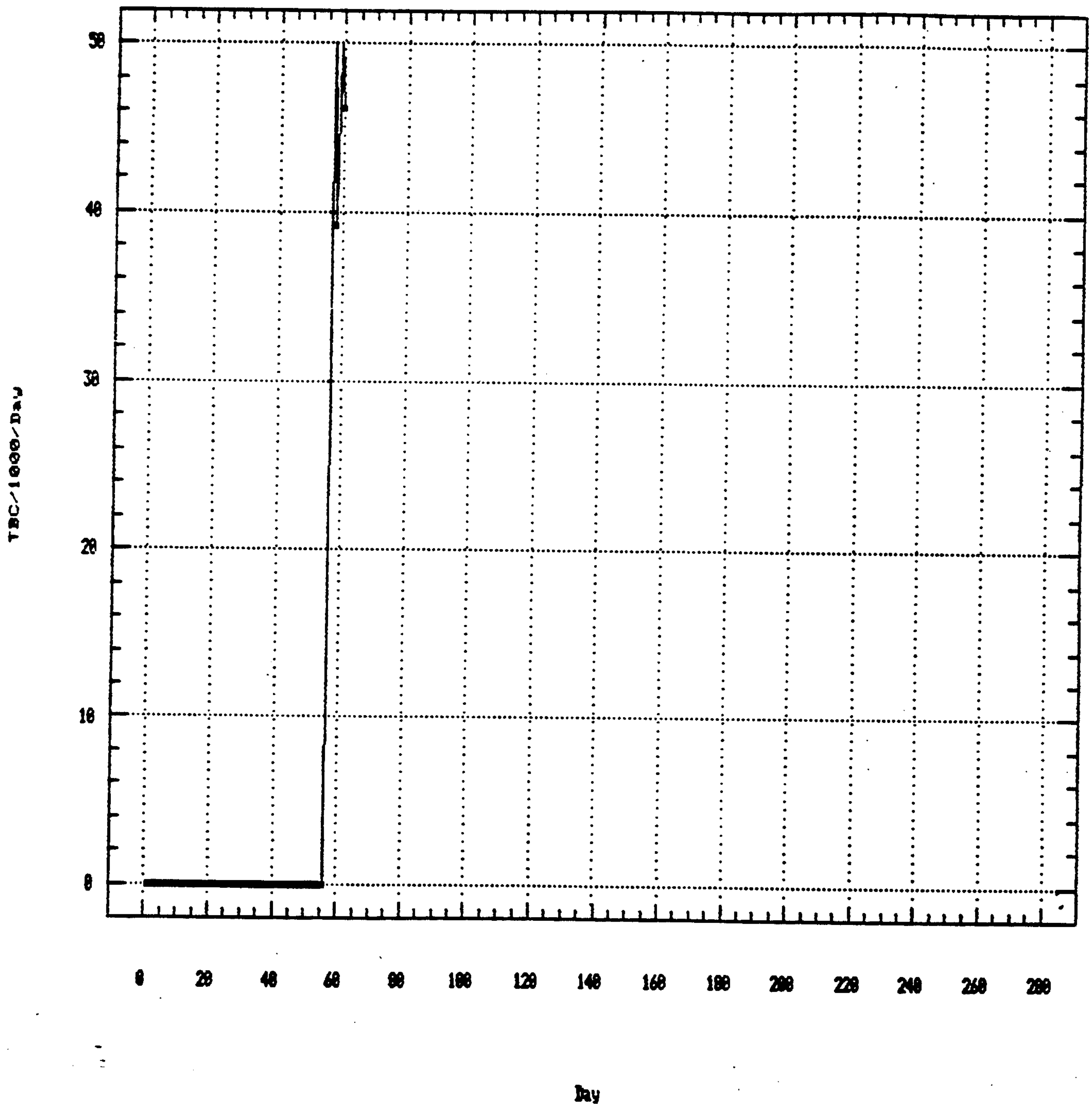
50
40
30
20
10
0
TBC/1000/Day
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '54'



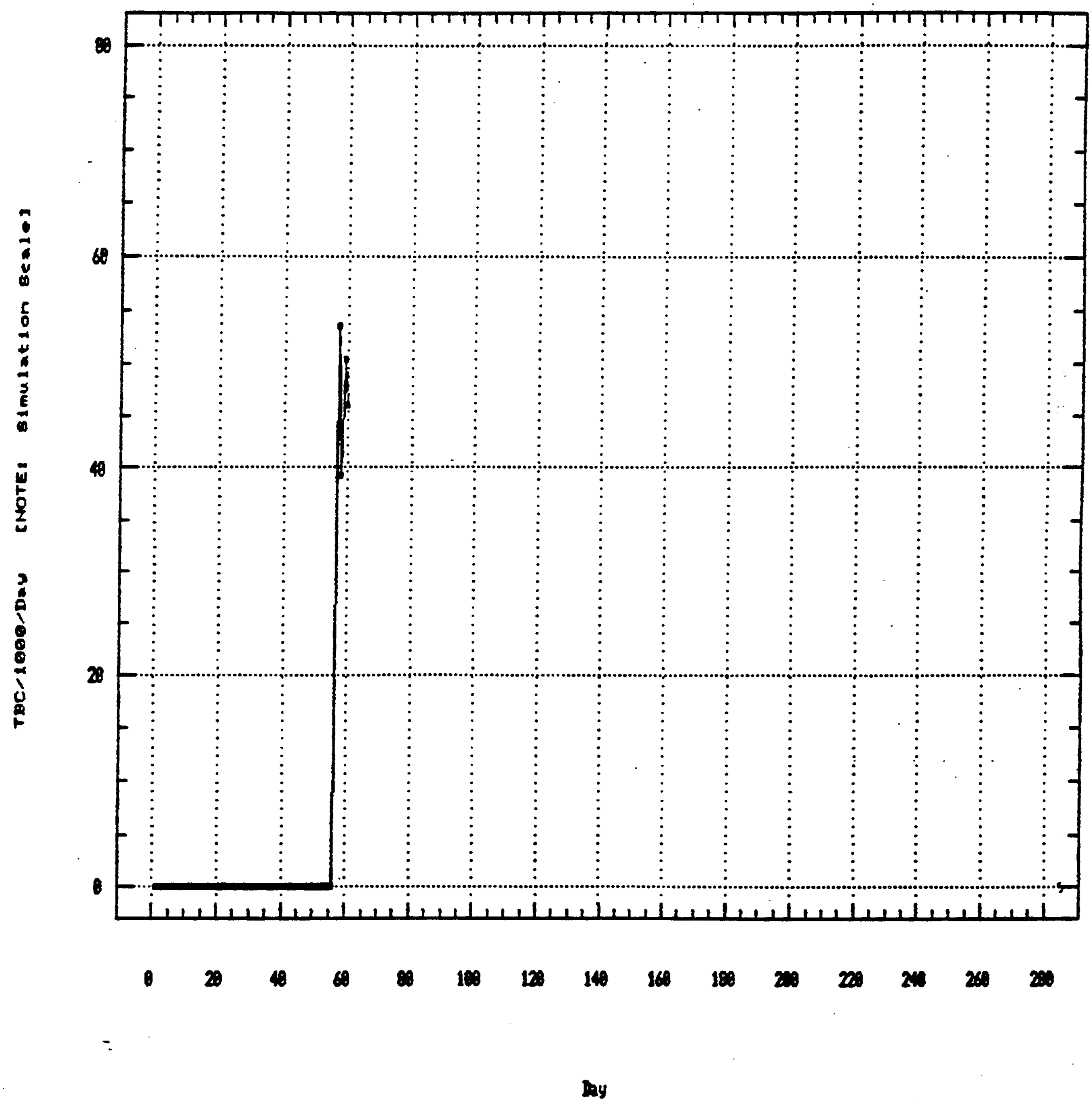
TBC/1000/Day (NOTE: Simulation Scale)
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '55'

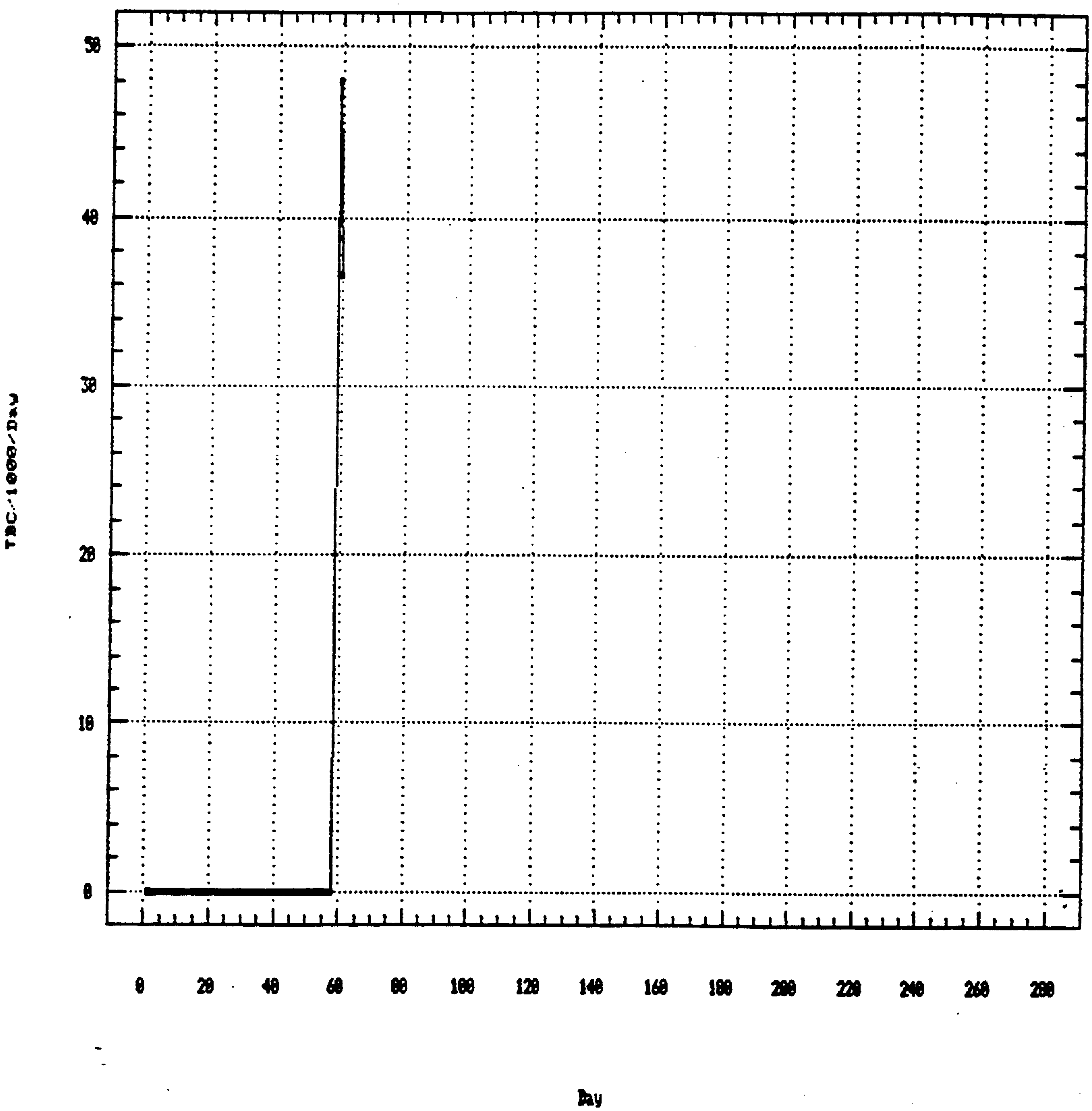


TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

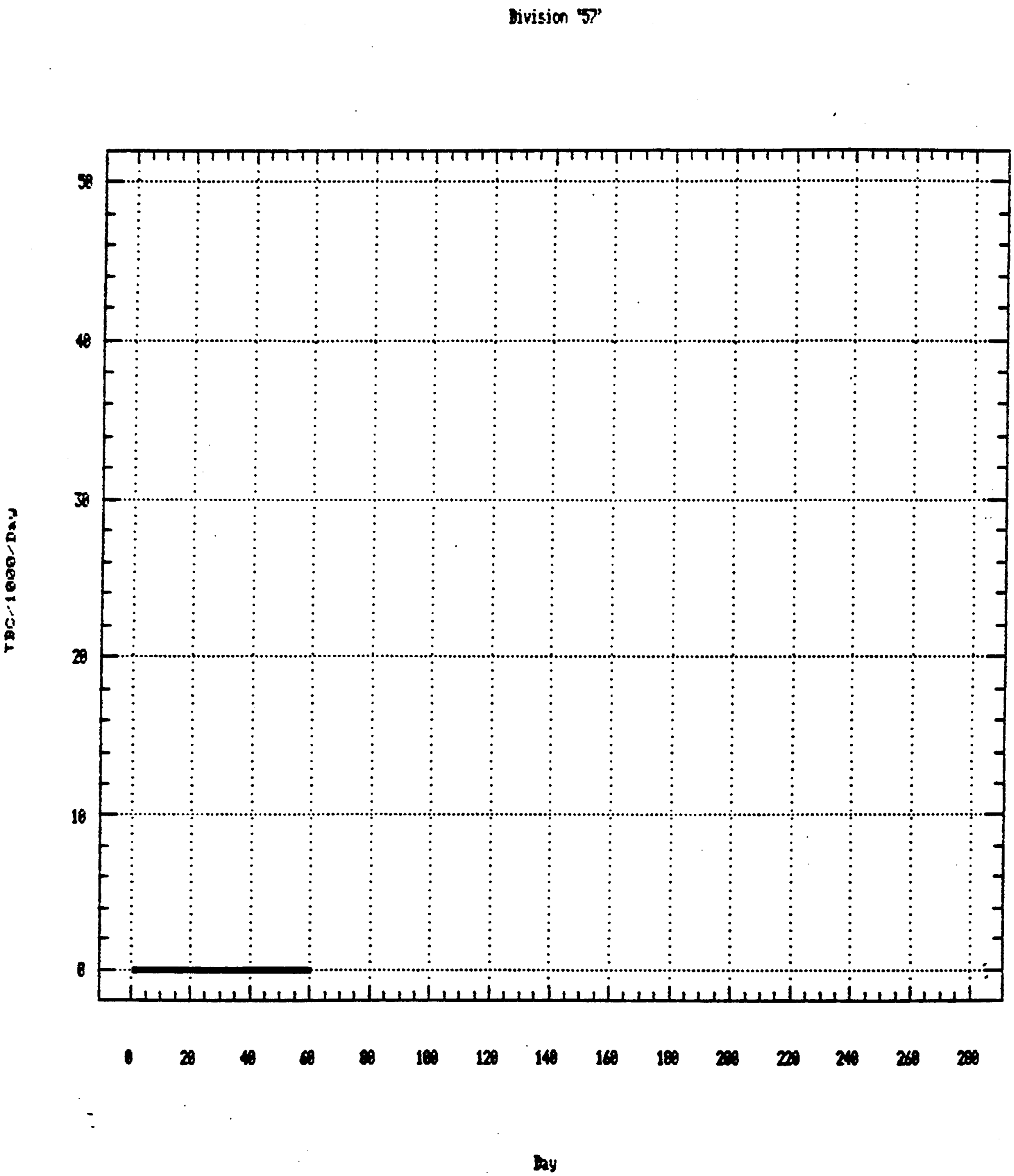
Division '55'


TBC/1000/Day (NOTE: Simulation Scale)
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '56'

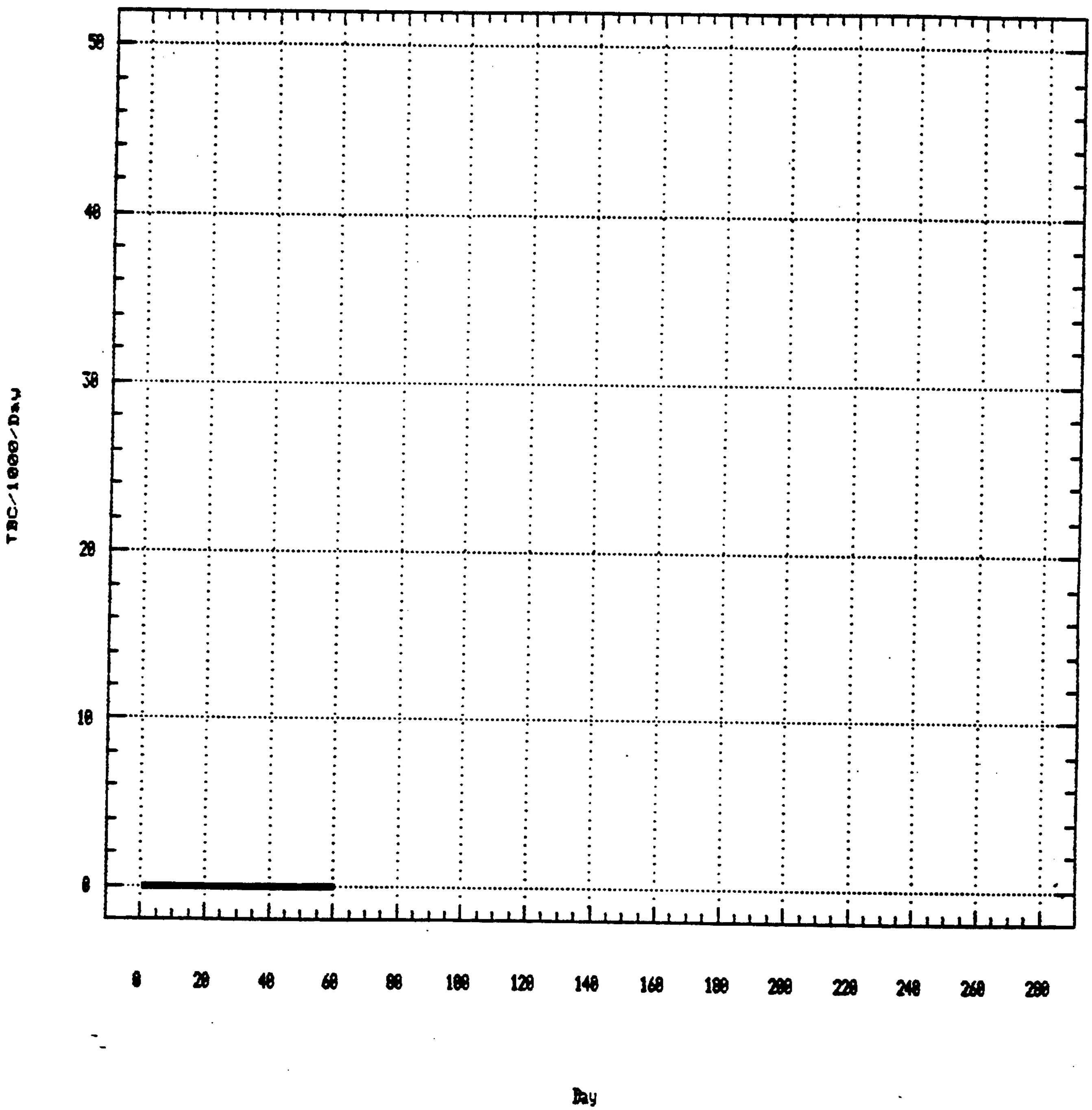


TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

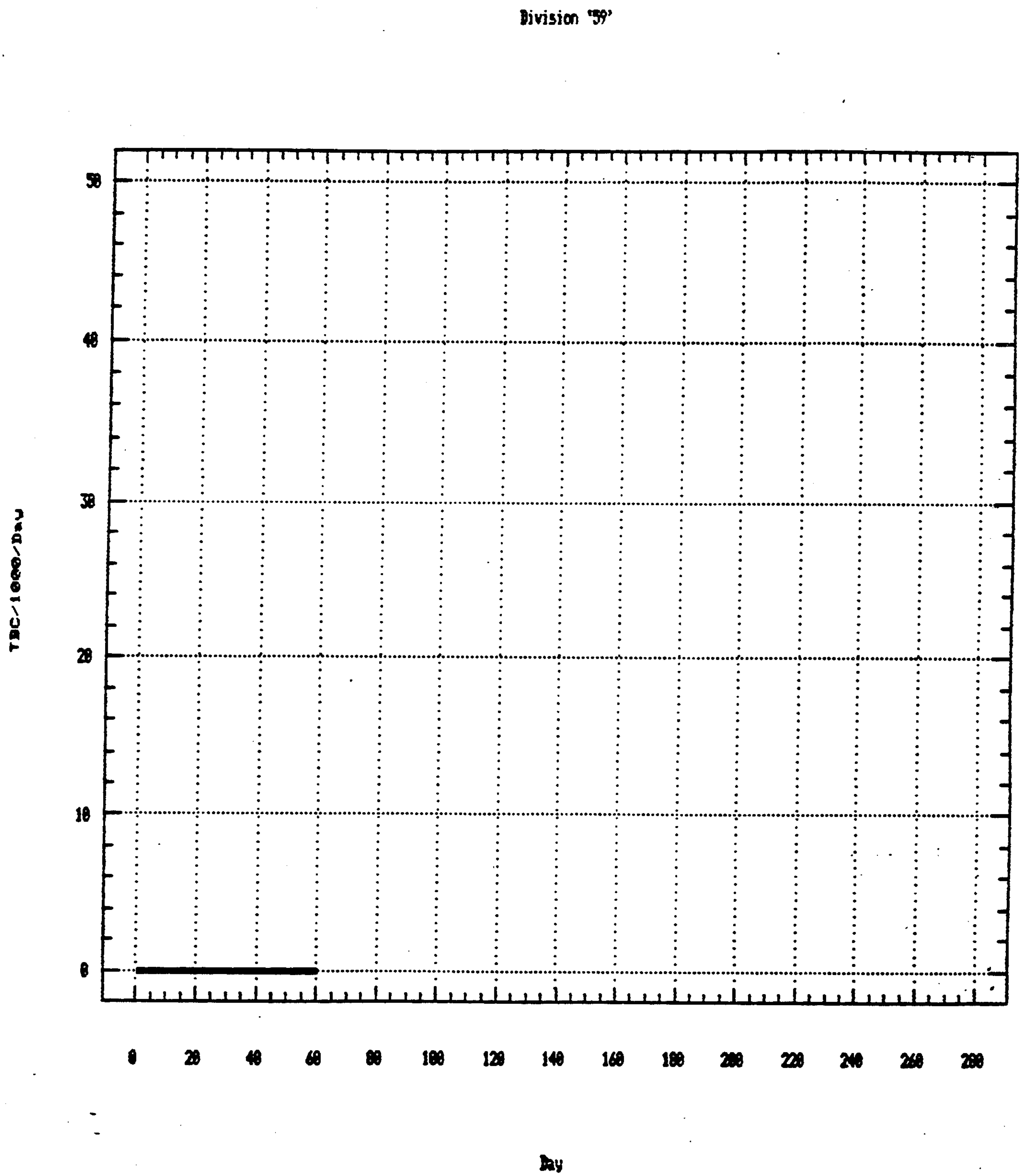


Division '57'
50
40
30
20
10
0
TBC/1000/Day
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

Division '58'



TBC/1000/Day
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day


Division '59'
50
40
30
20
10
0
TBC/1000/Day
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

APPENDIX B

OMNIBUS 89 "RED" FORCE BATTLE CASUALTY RATES

APPENDIX B

OMNIBUS 89 "RED" FORCE BATTLE CASUALTY RATES

The following time series curves show the daily casualty rates for higher-echelon Soviet/Warsaw Pact forces as depicted in the Omnibus 89 (CEM-based) simulation.

The structure of the graphs is identical to that described in Appendix A for Blue forces, with the exception of the ordinate axis. To accommodate most rate values for army- and corps-size formations, a single axis height was chosen for each echelon: 100 for army, and 140 for corps.[1] These special "simulation scales" must be kept in mind when attempting to compare these rate curves to either the Blue rate curves in Appendix A or the empirical rate curves included in our first report.

The Red force rates shown here are limited to army- and corps-size formations. We do not include division counts or counting rules for sizing the listed echelons.

In keeping with Soviet parlance, an army-size force is termed a "*Front*" while a corps-size force is termed an "army."

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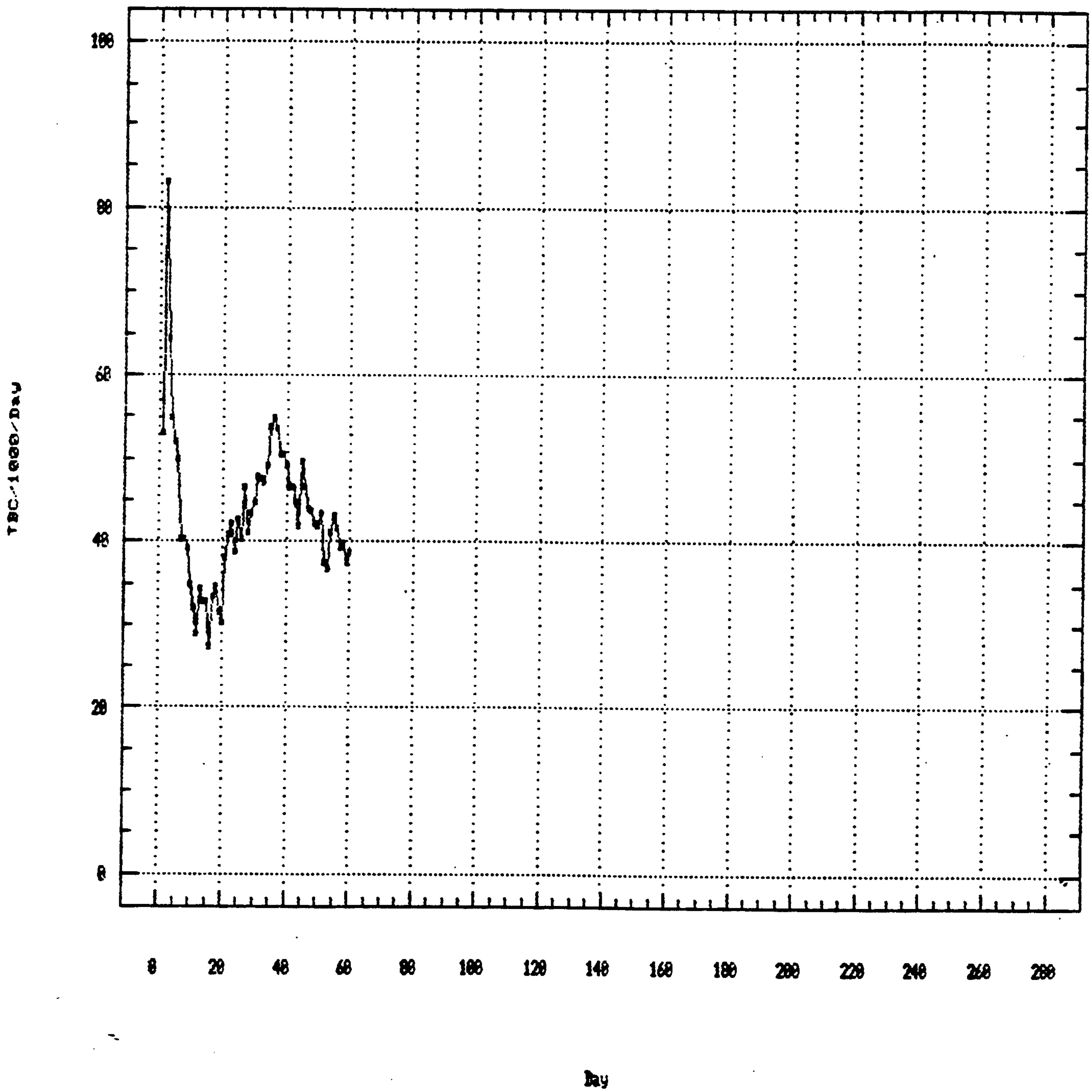
[1]We do not attempt here (as we did in Appendix A) to reproduce the empirical ordinate scales first before showing the simulation scales for two reasons: the Red force rates simply overwhelm the empirical scales; and we have no reason to think, as we do in the case of rates for Blue forces, that rates for simulated Red units might be comparable to empirical rates for Allied (or German) units gleaned from World War II. We have reason to believe, instead, that rates for Soviet forces (and forces using Soviet methods) may be consistently higher than rates that apply to these other forces. We do not address the several reasons for this judgment.

RED FRONT GRAPHS

(Pages B-7 to B-18)

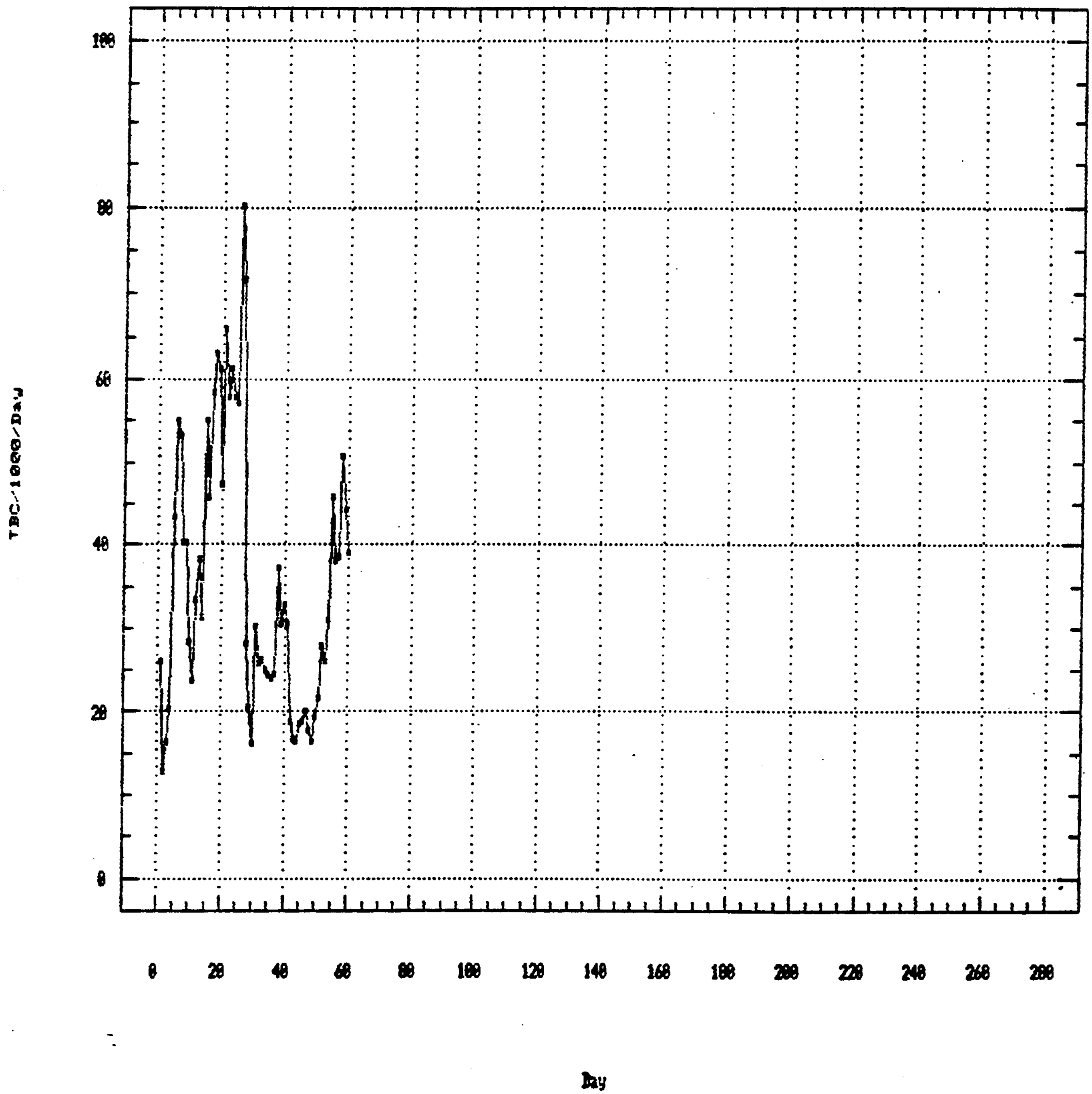
Total Force

(Average Daily Division-level Rate)



Front 1

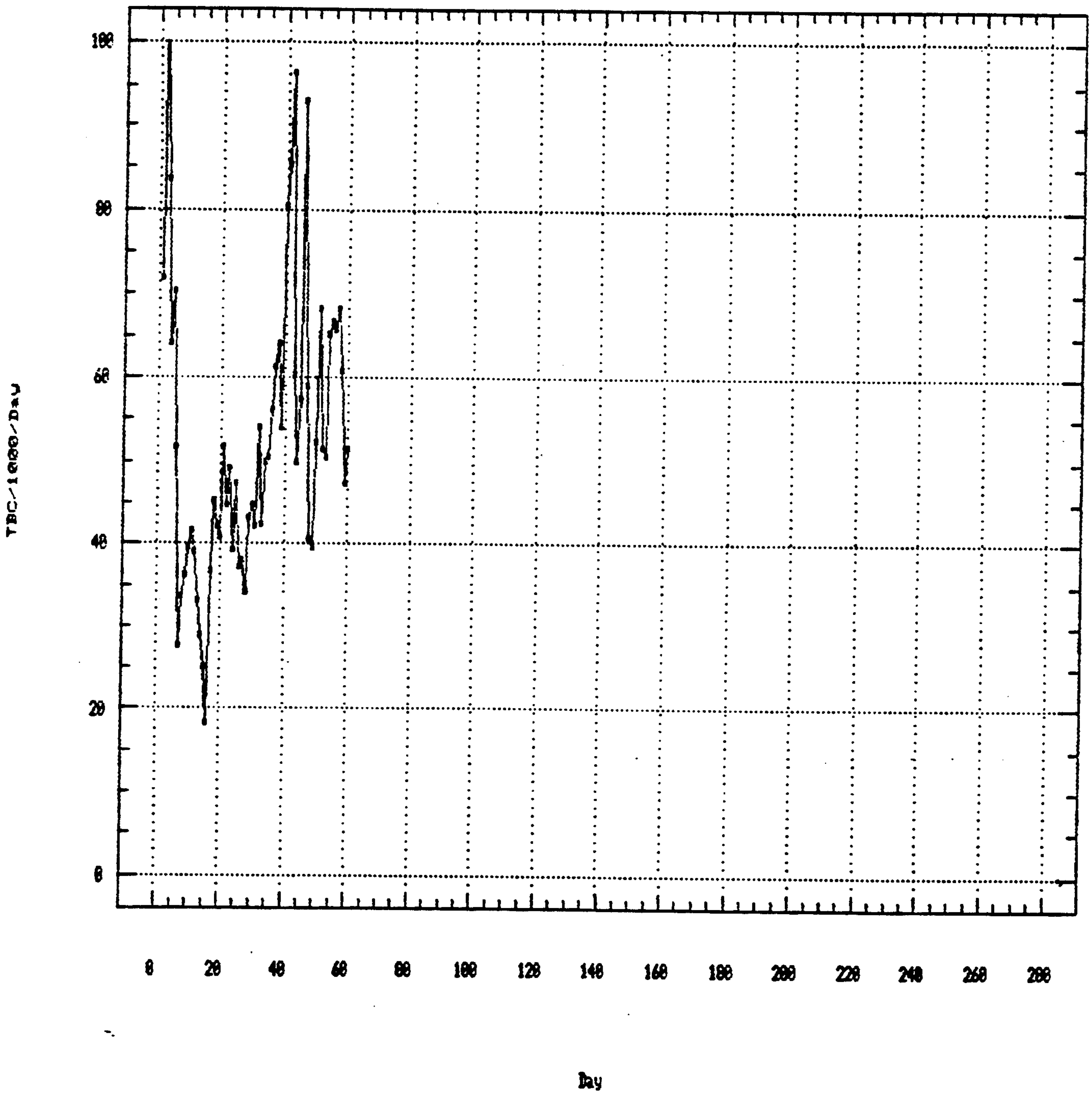
(Average Daily Division-level Rate)



Front 2

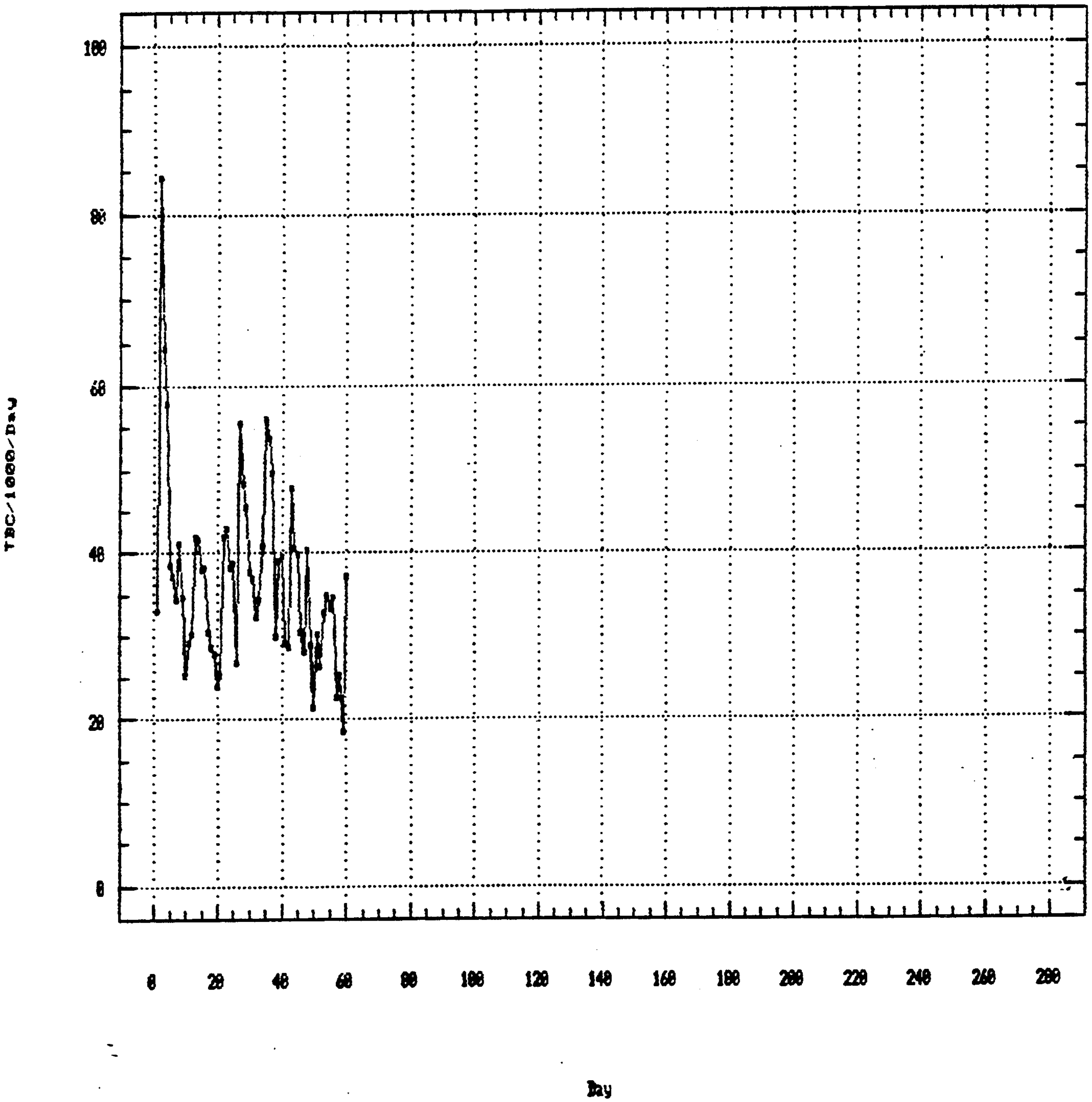
(Average Daily Division-level Rate)

113



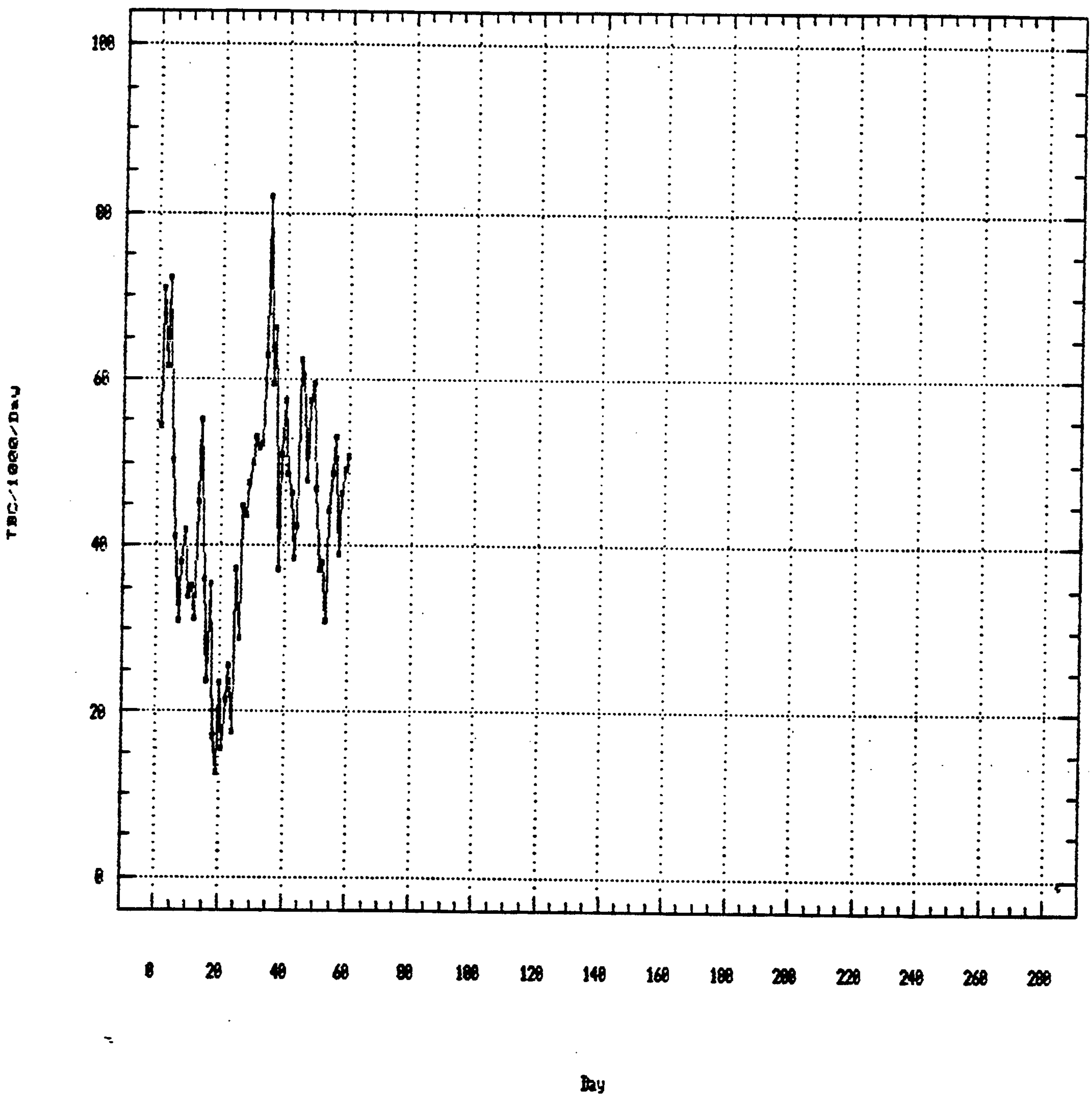
Front 3

(Average Daily Division-level Rate)



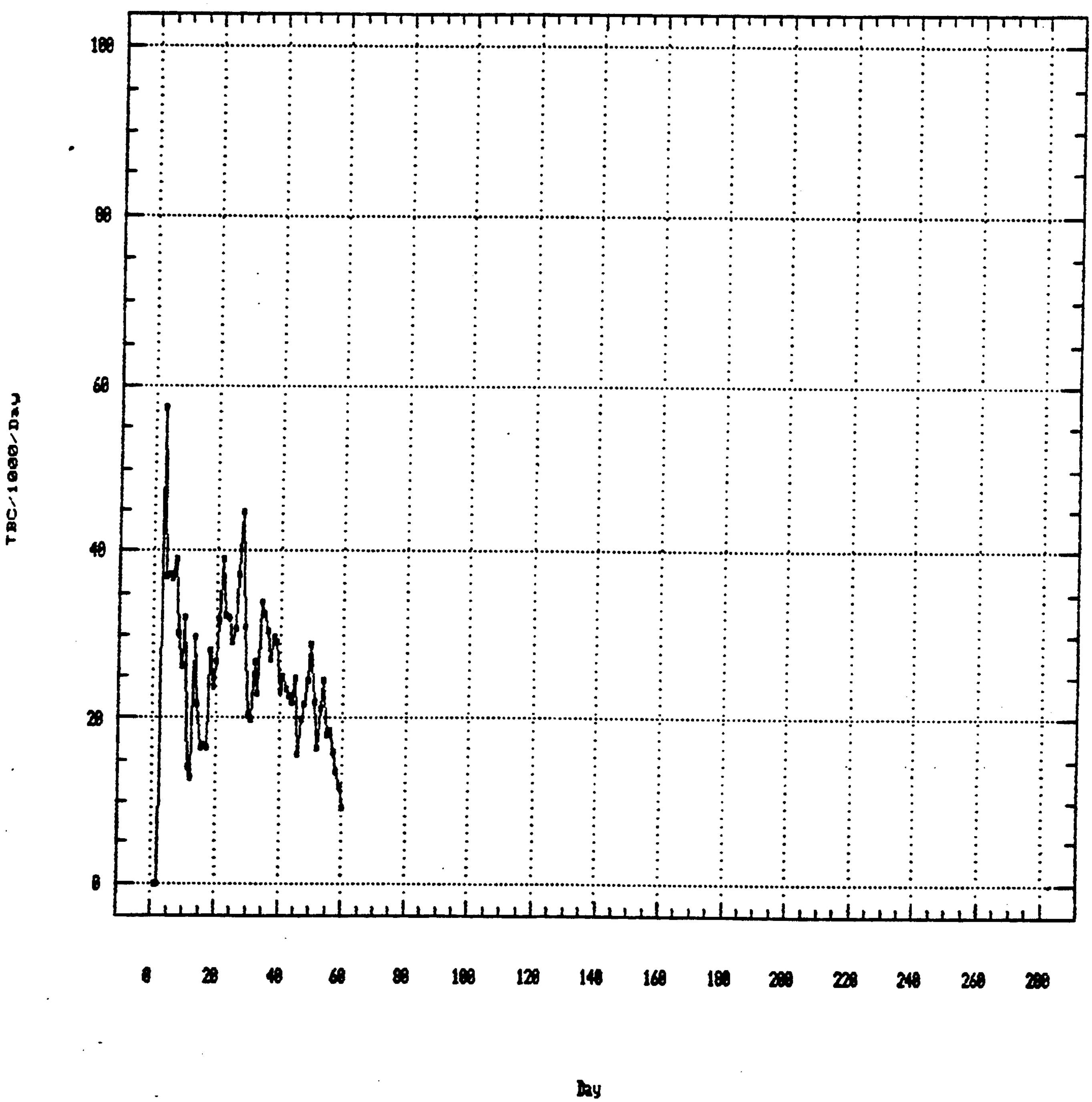
Front 4

(Average Daily Division-level Rate)



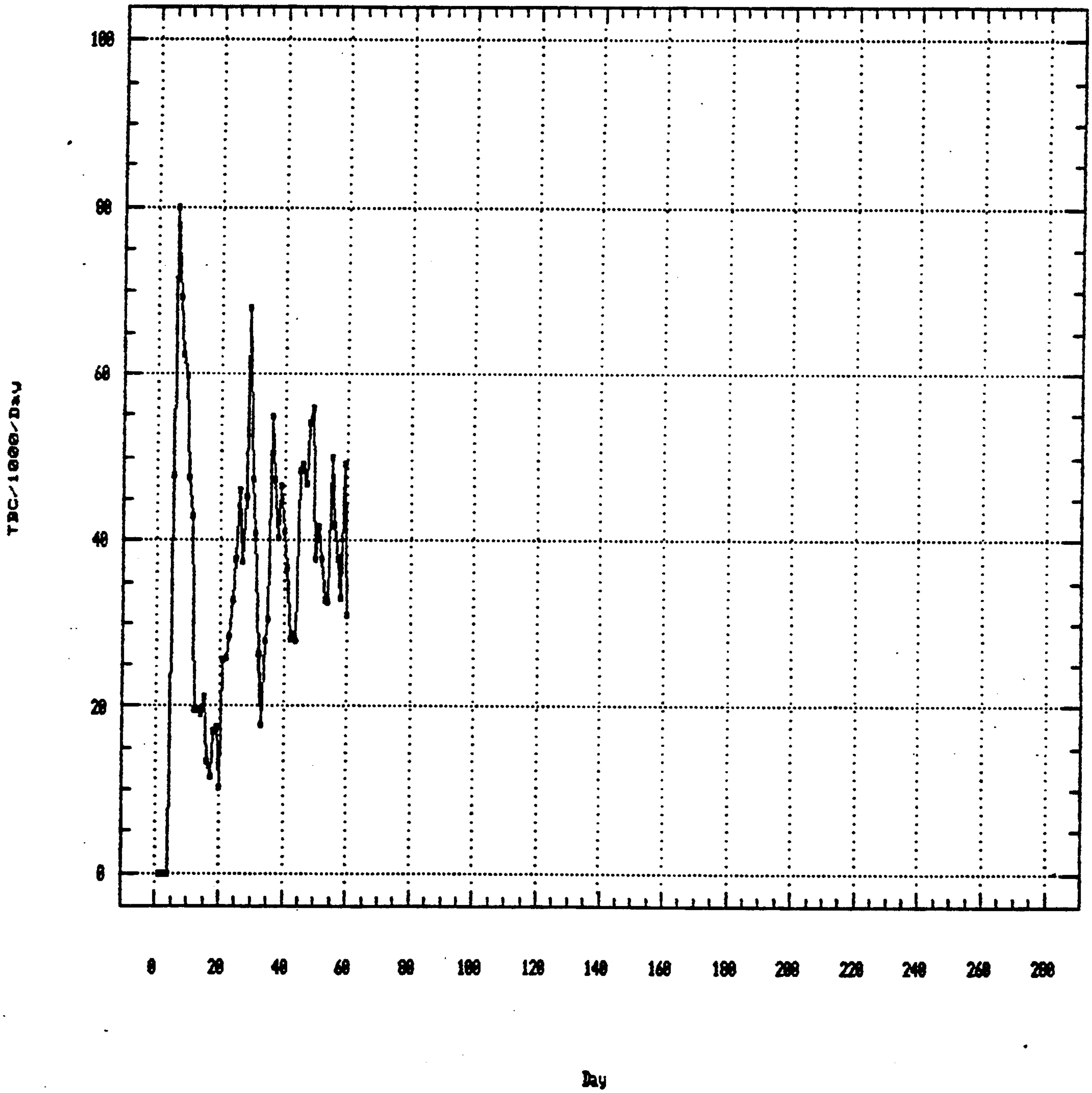
'Created Front 1'

(Average Daily Division-level Rate)



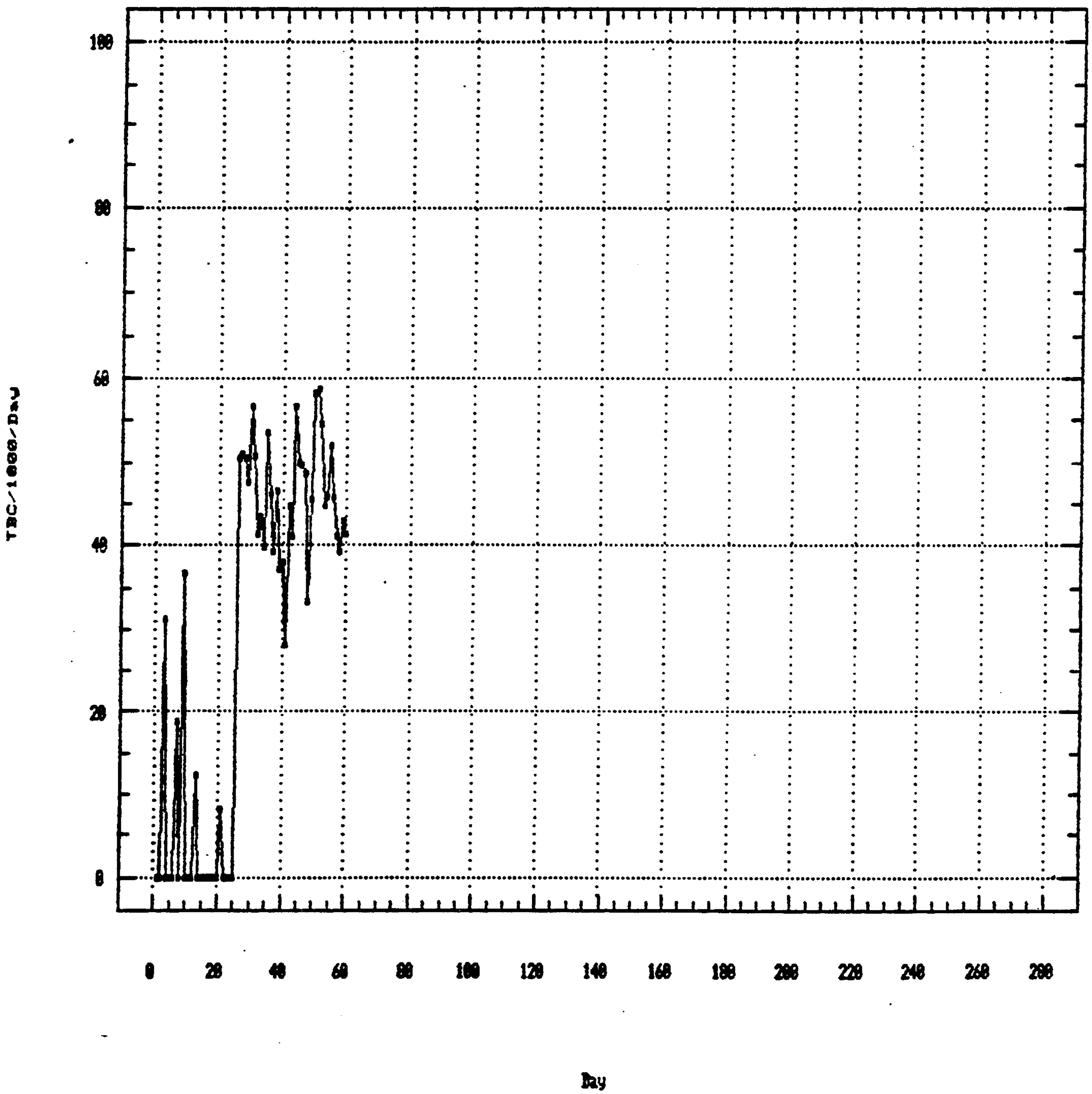
'Created Front 2'

(Average Daily Division-level Rate)



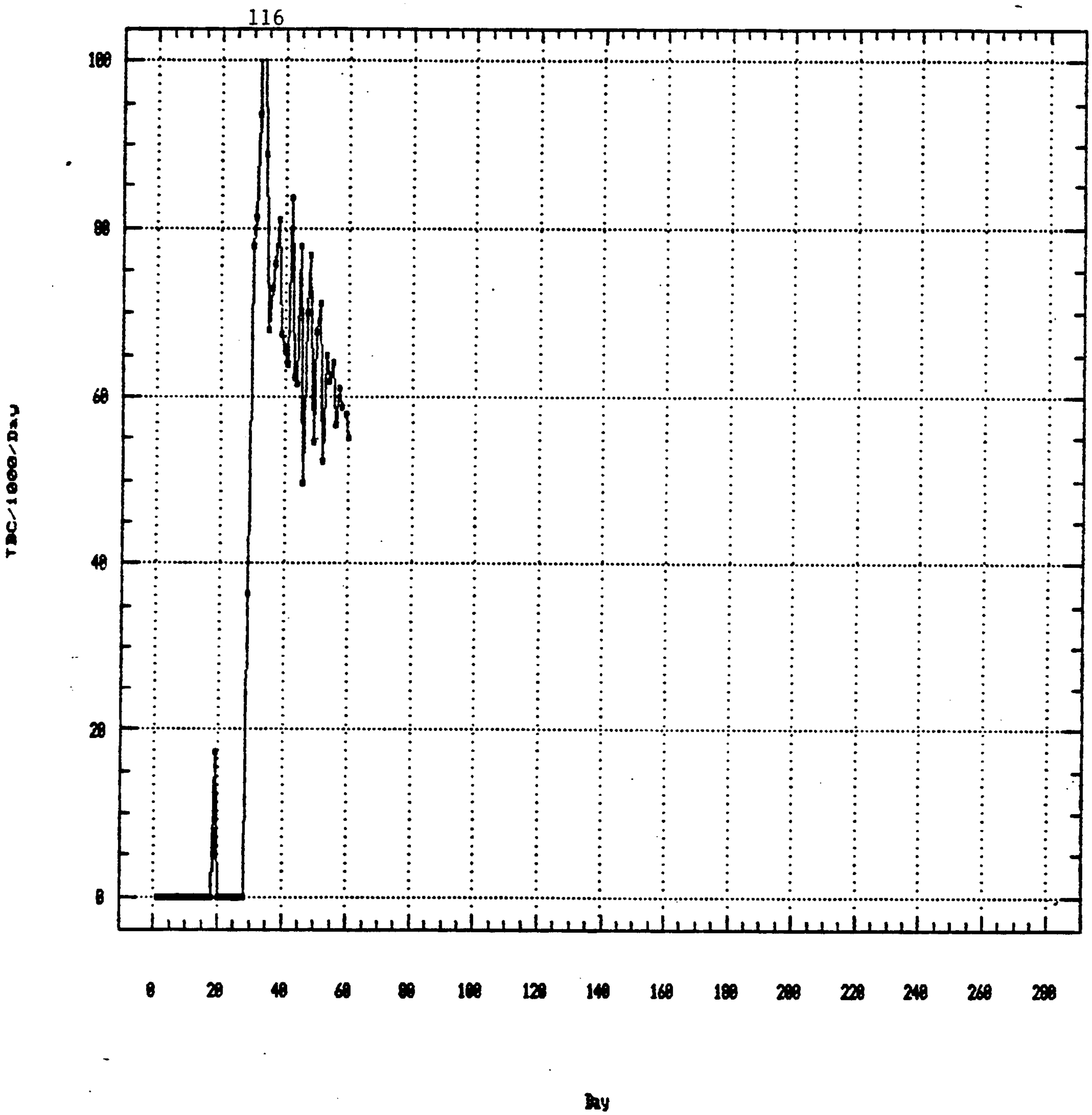
'Created Front 3'

(Average Daily Division-level Rate)



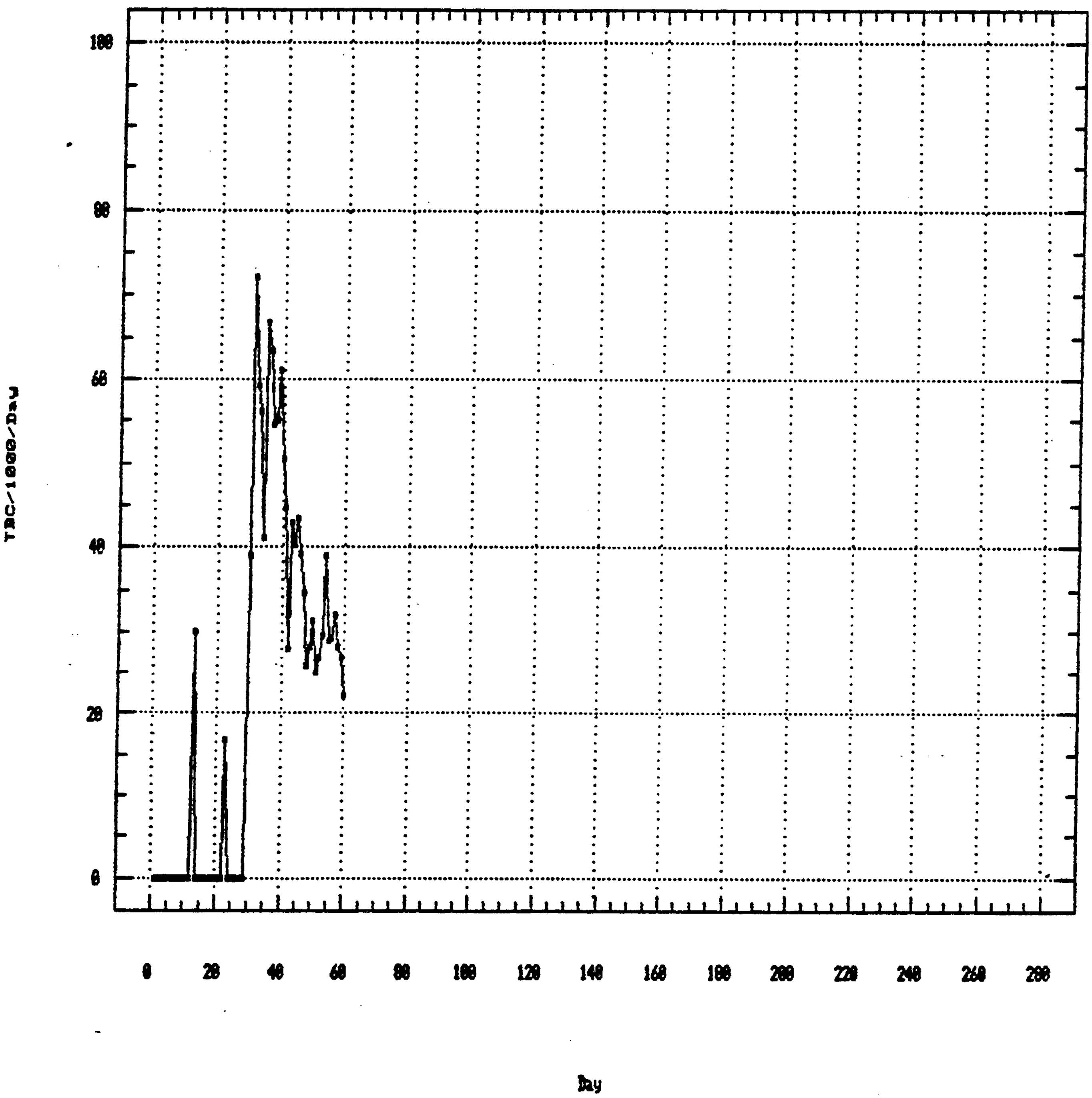
'Created Front 4'

(Average Daily Division-level Rate)



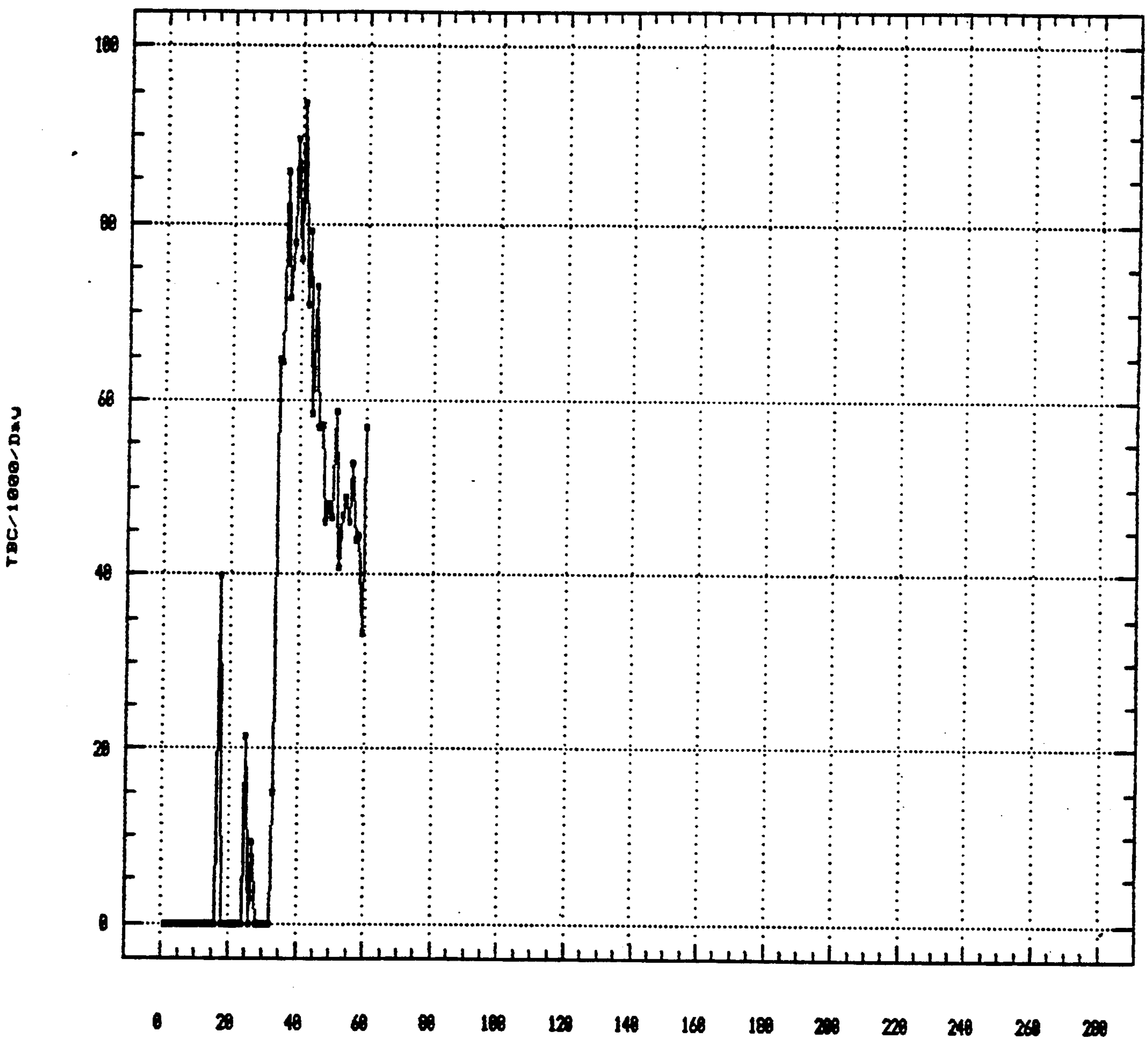
'Created Front 5'

(Average Daily Division-level Rate)



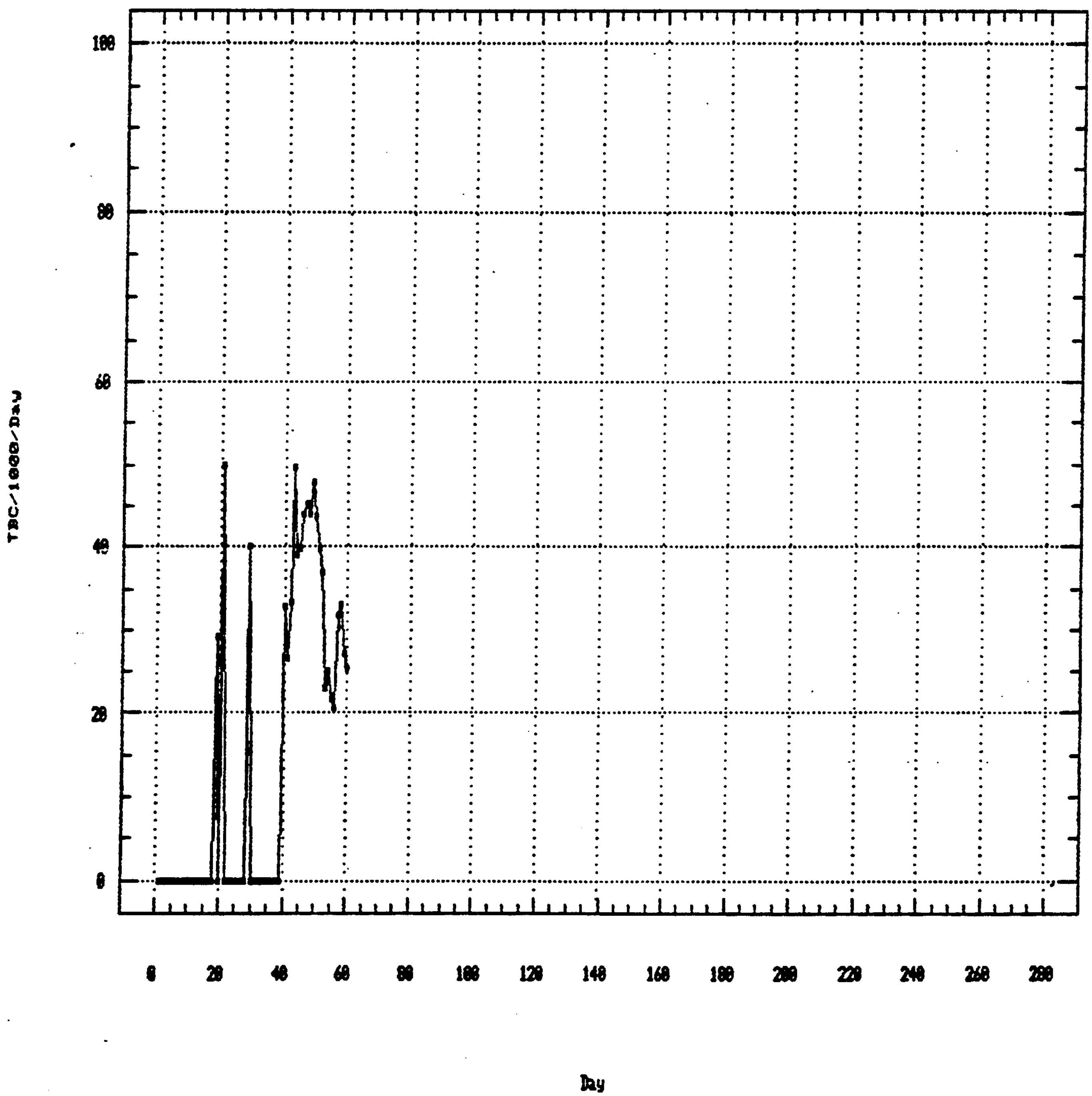
'Created Front 6'

(Average Daily Division-level Rate)



'Created Front 7'

(Average Daily Division-level Rate)

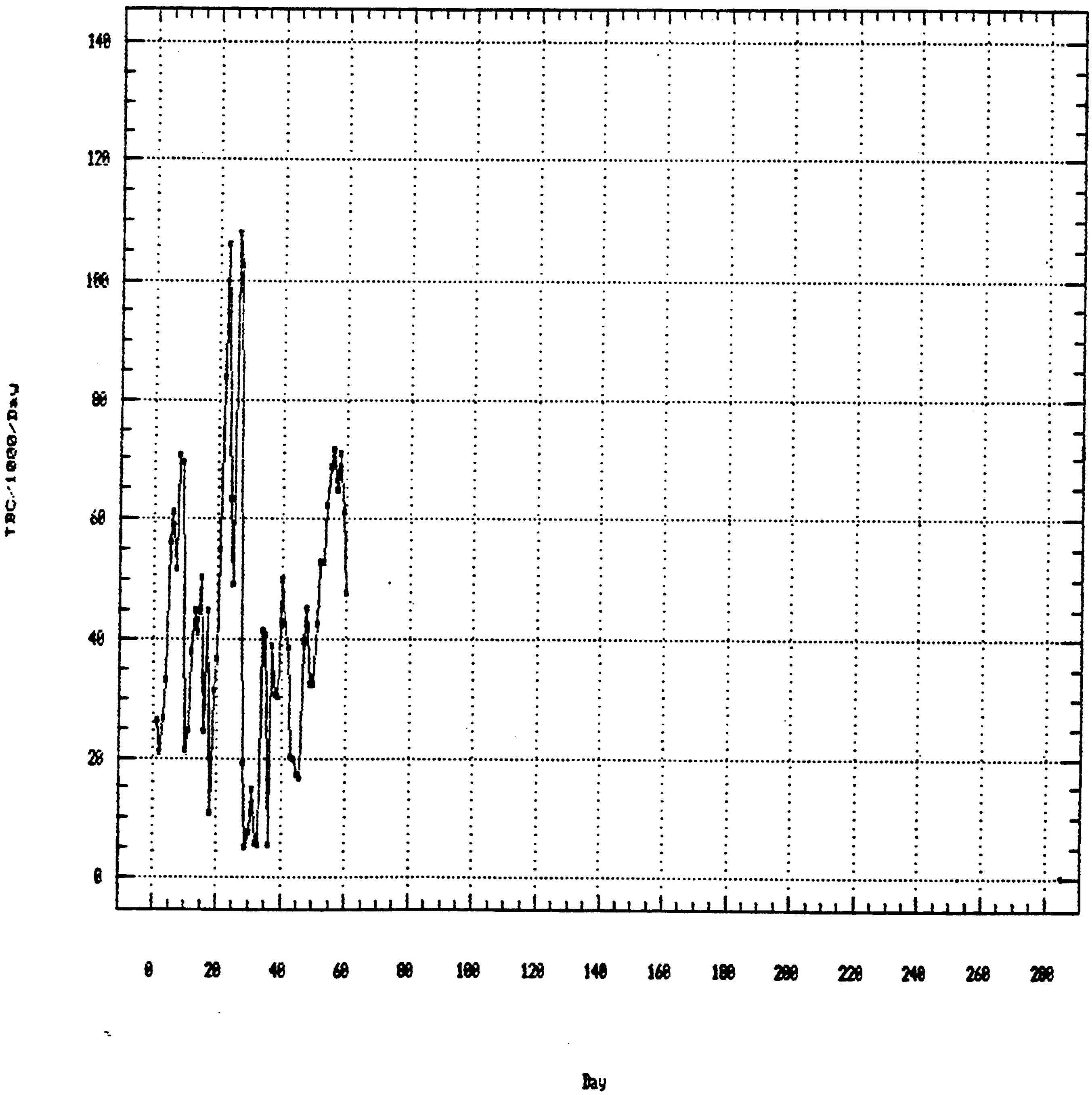


RED ARMY GRAPHS

(Pages B-21 to B-60)

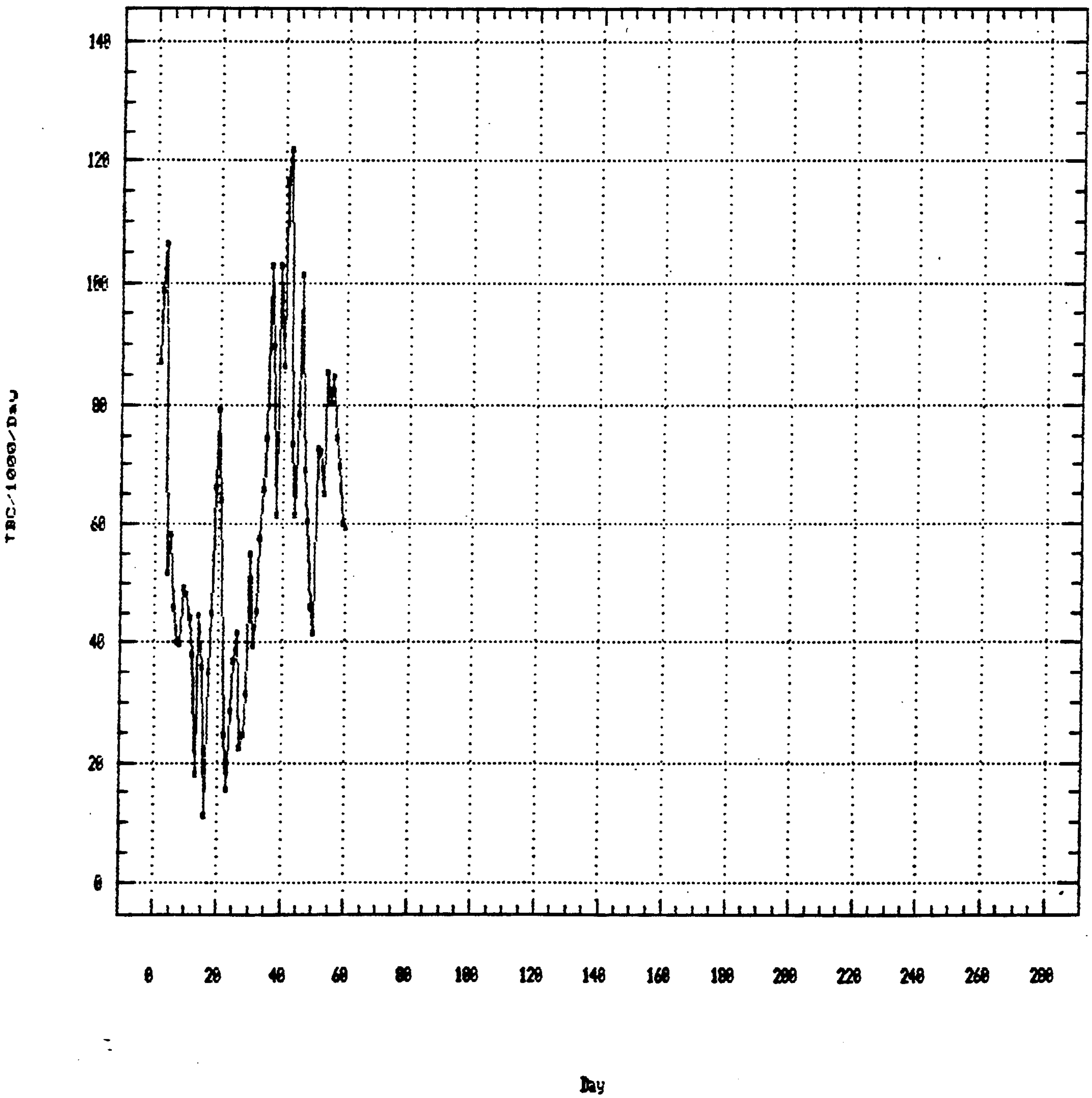
Army I-I

(Average Daily Division-level Rate)



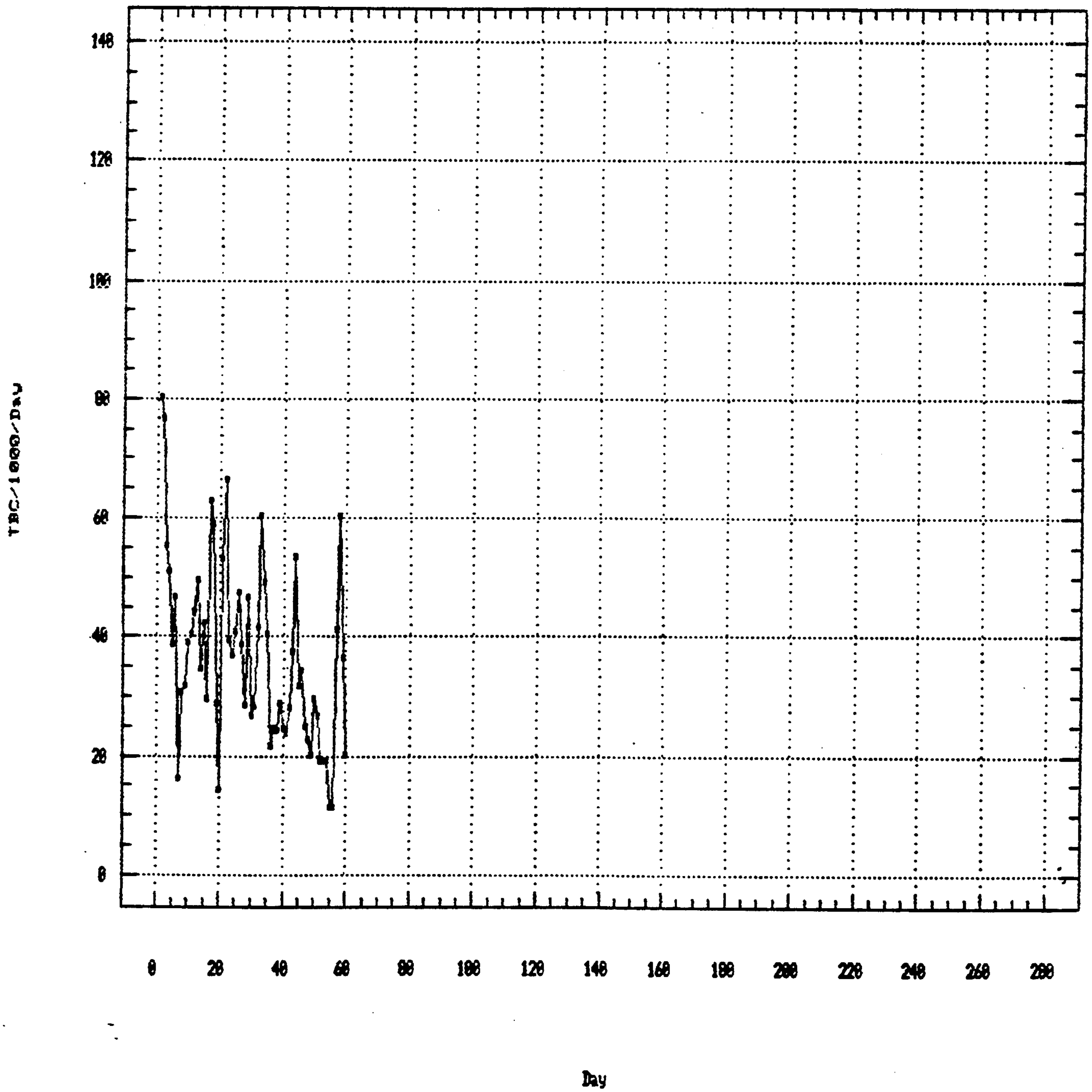
Army 2-1

(Average Daily Division-level Rate)



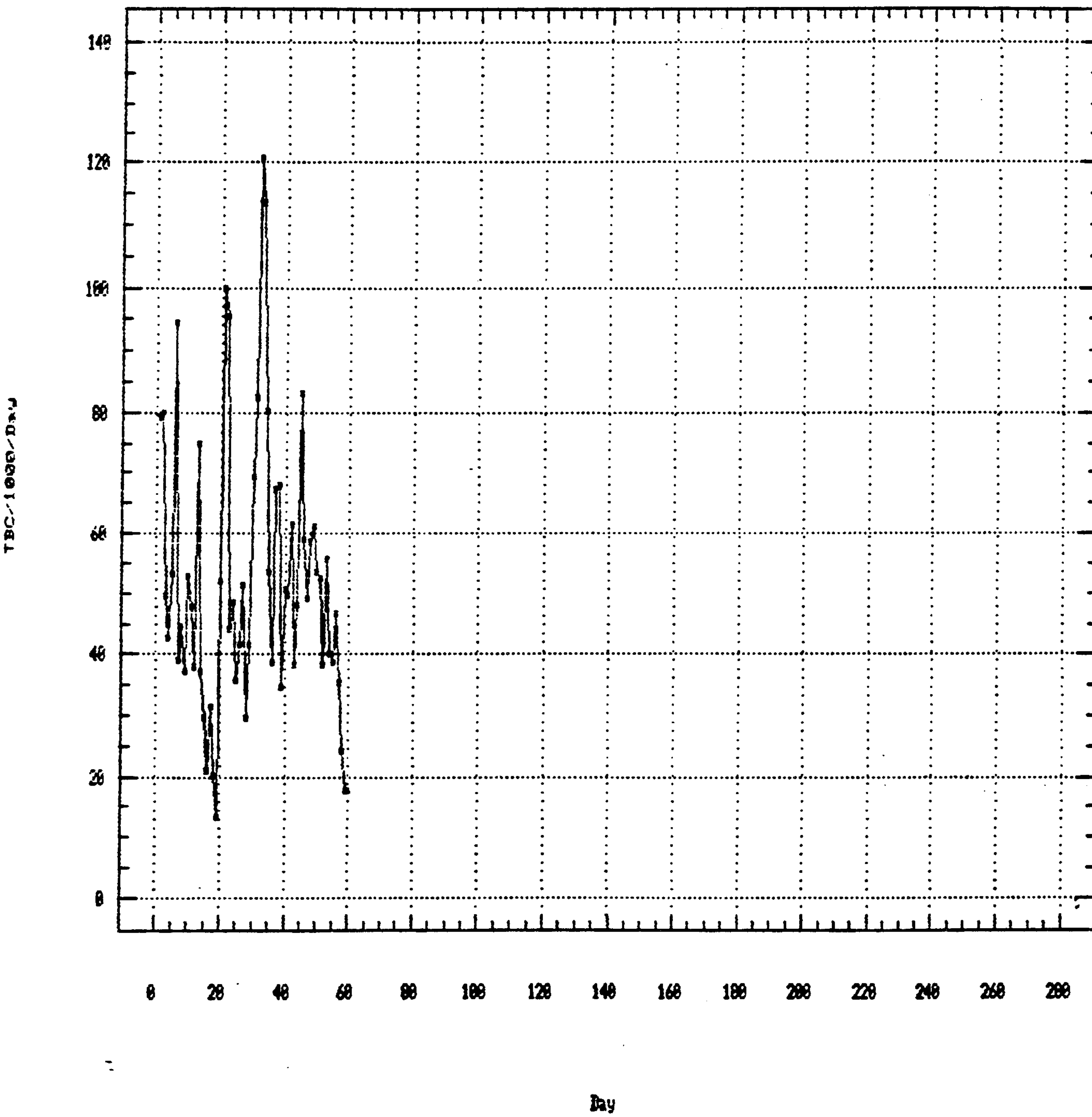
Army 2-2

(Average Daily Division-level Rate)



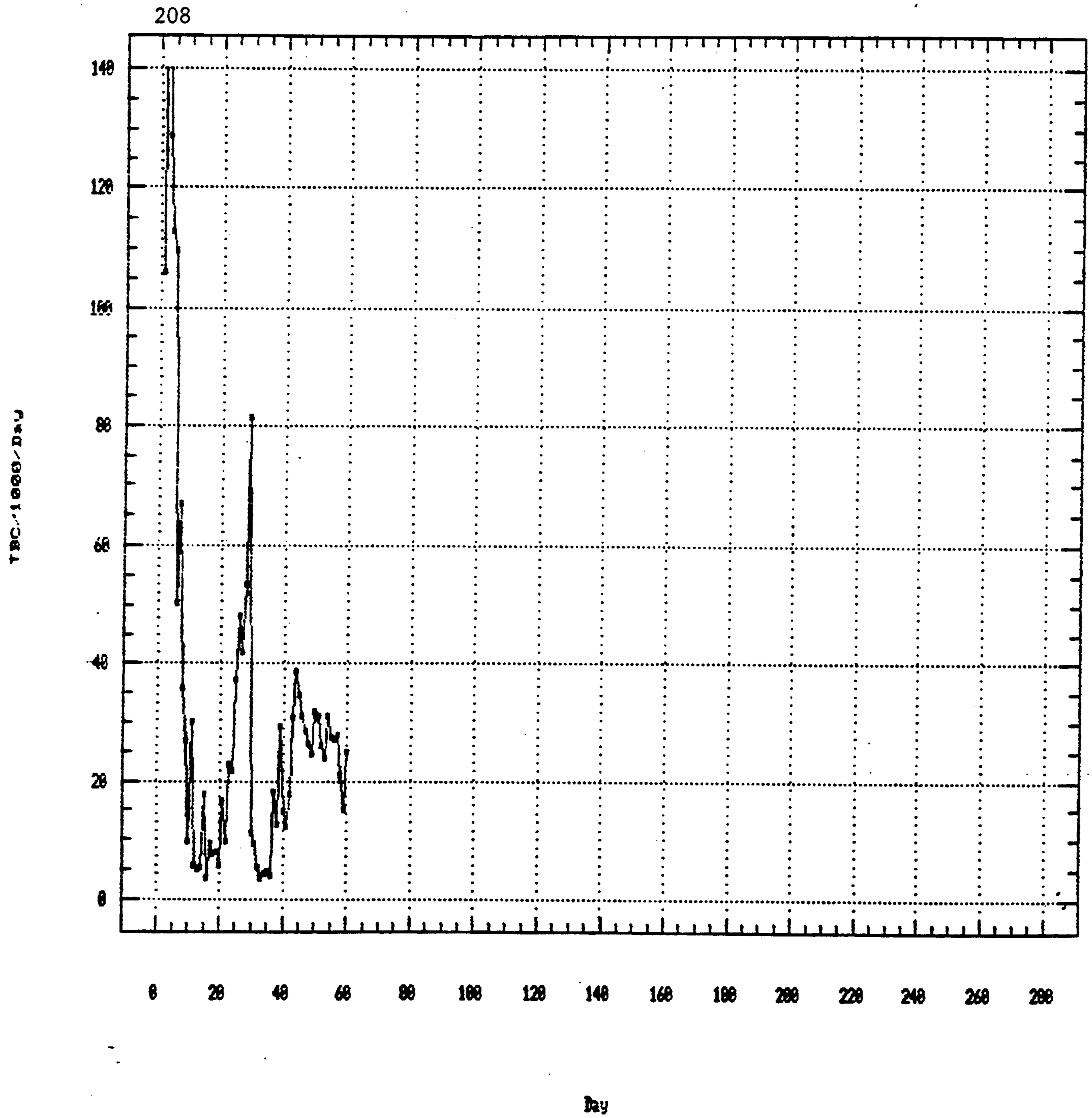
Army 2-3

(Average Daily Division-level Rate)



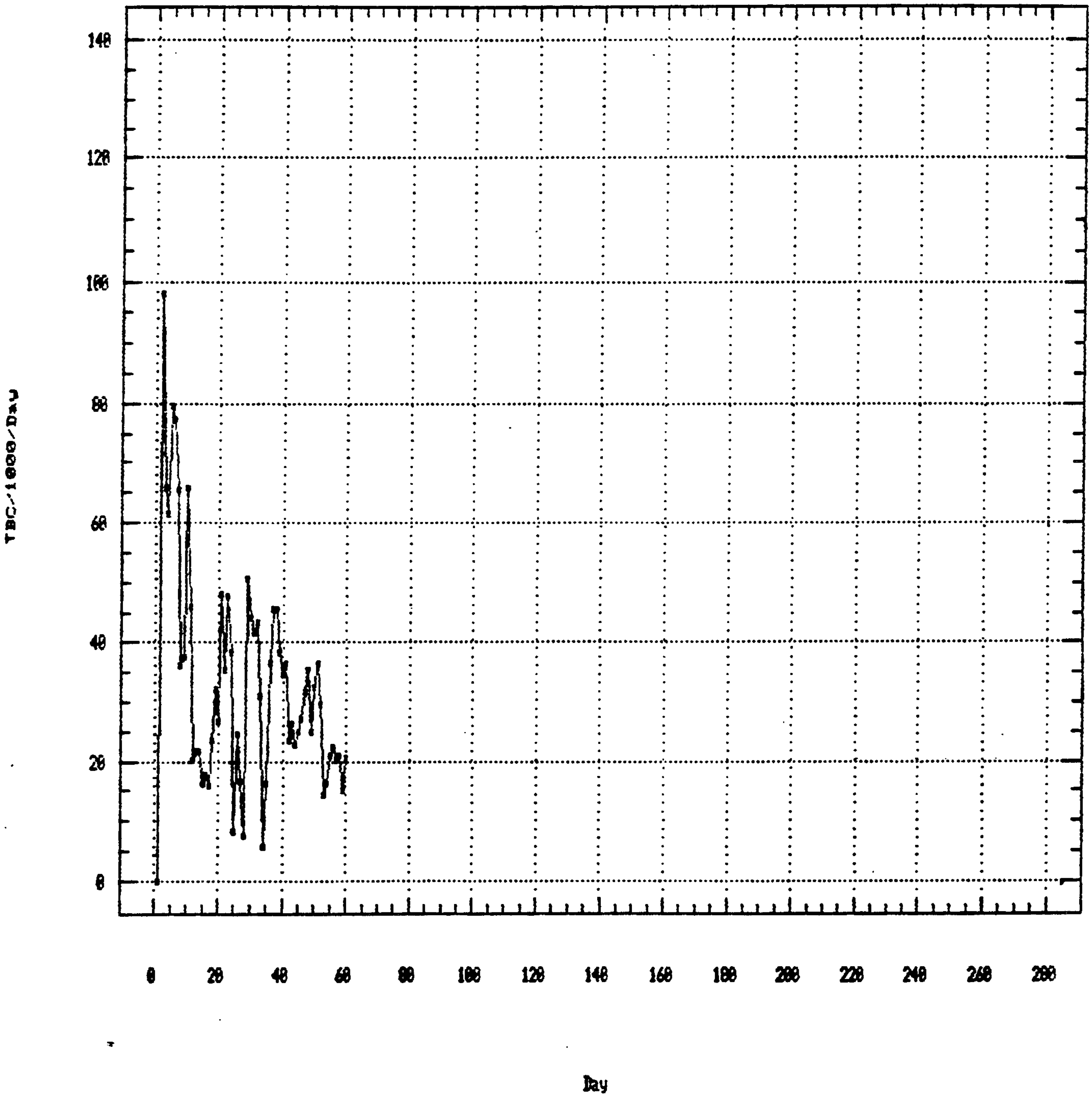
Army 2-4

(Average Daily Division-level Rate)



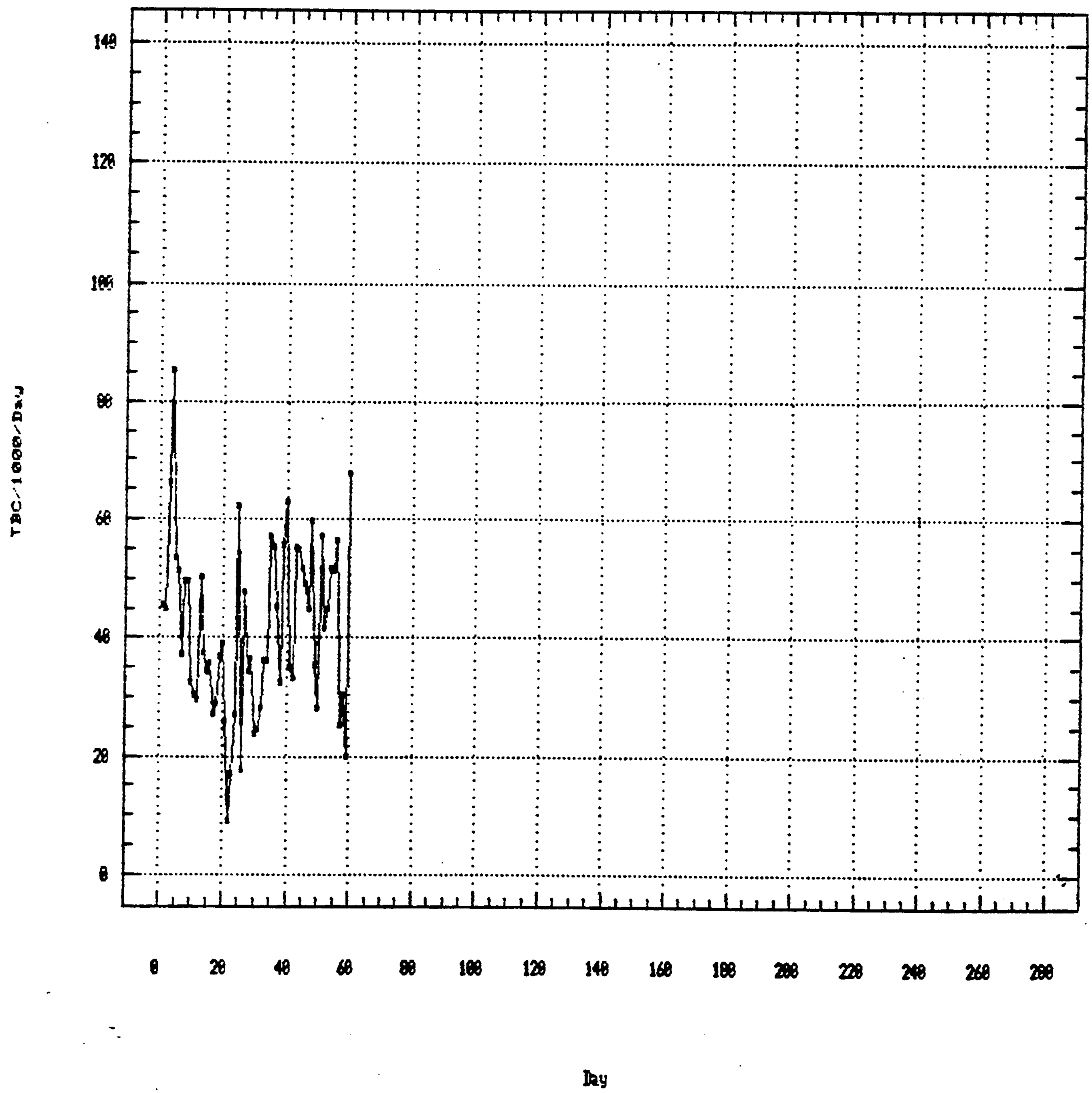
Army 2-5

(Average Daily Division-level Rate)



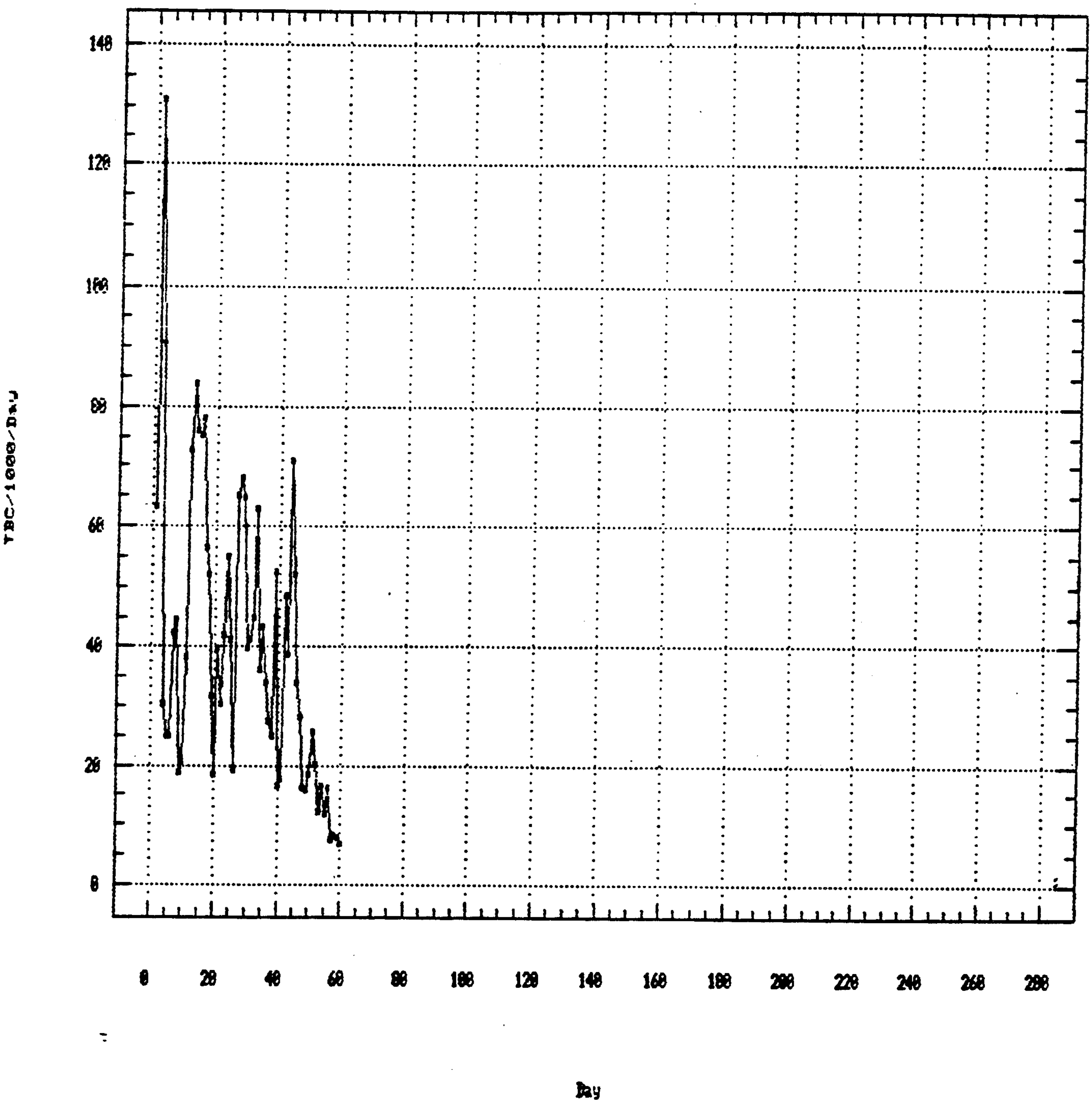
Army 3-1

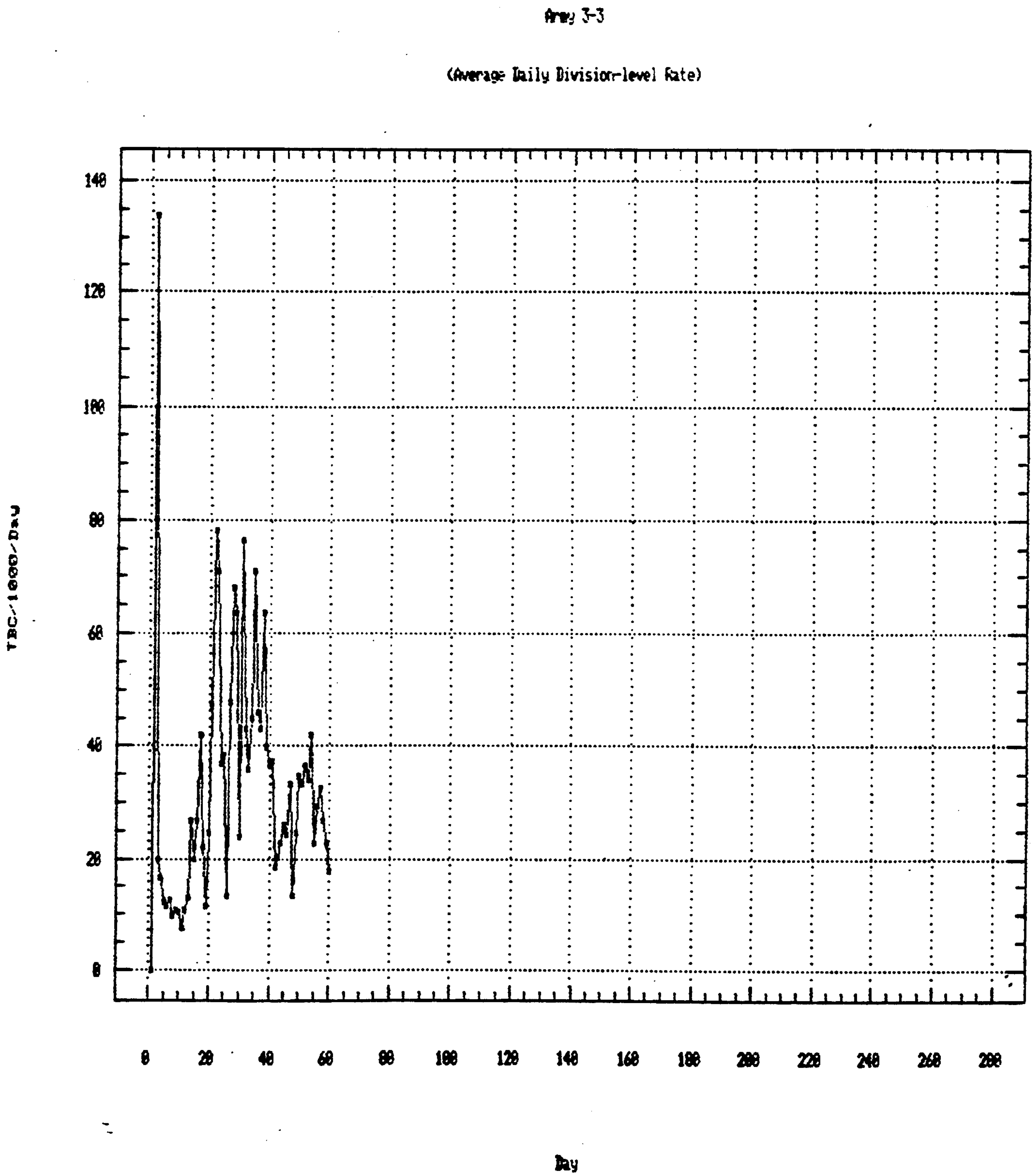
(Average Daily Division-level Rate)



Army 3-2

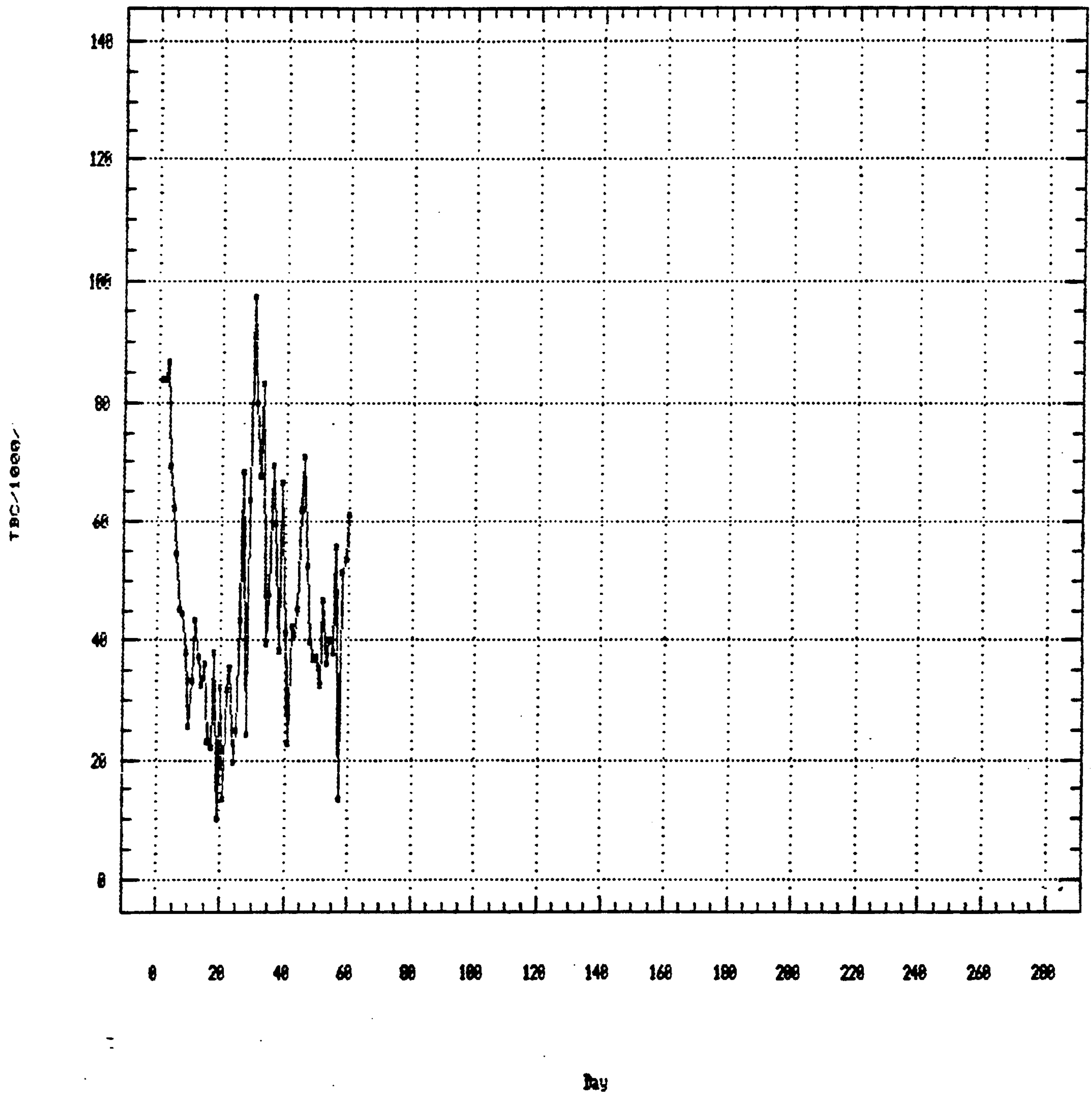
(Average Daily Division-level Rate)




Army 3-3
(Average Daily Division-level Rate)
TBC/1000/Day
140
120
100
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

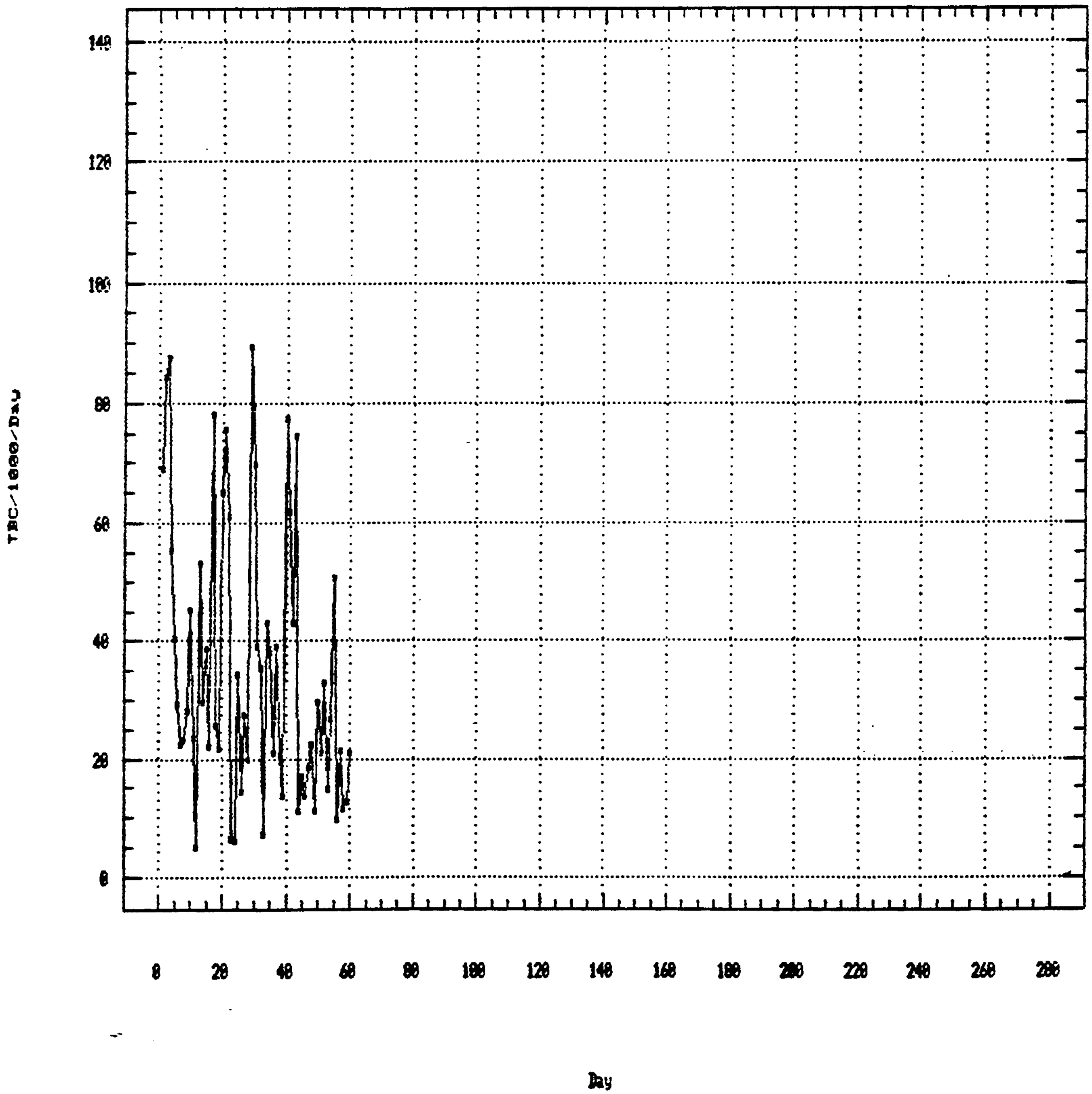
Army 4-1

(Average Daily Division-level Rate)



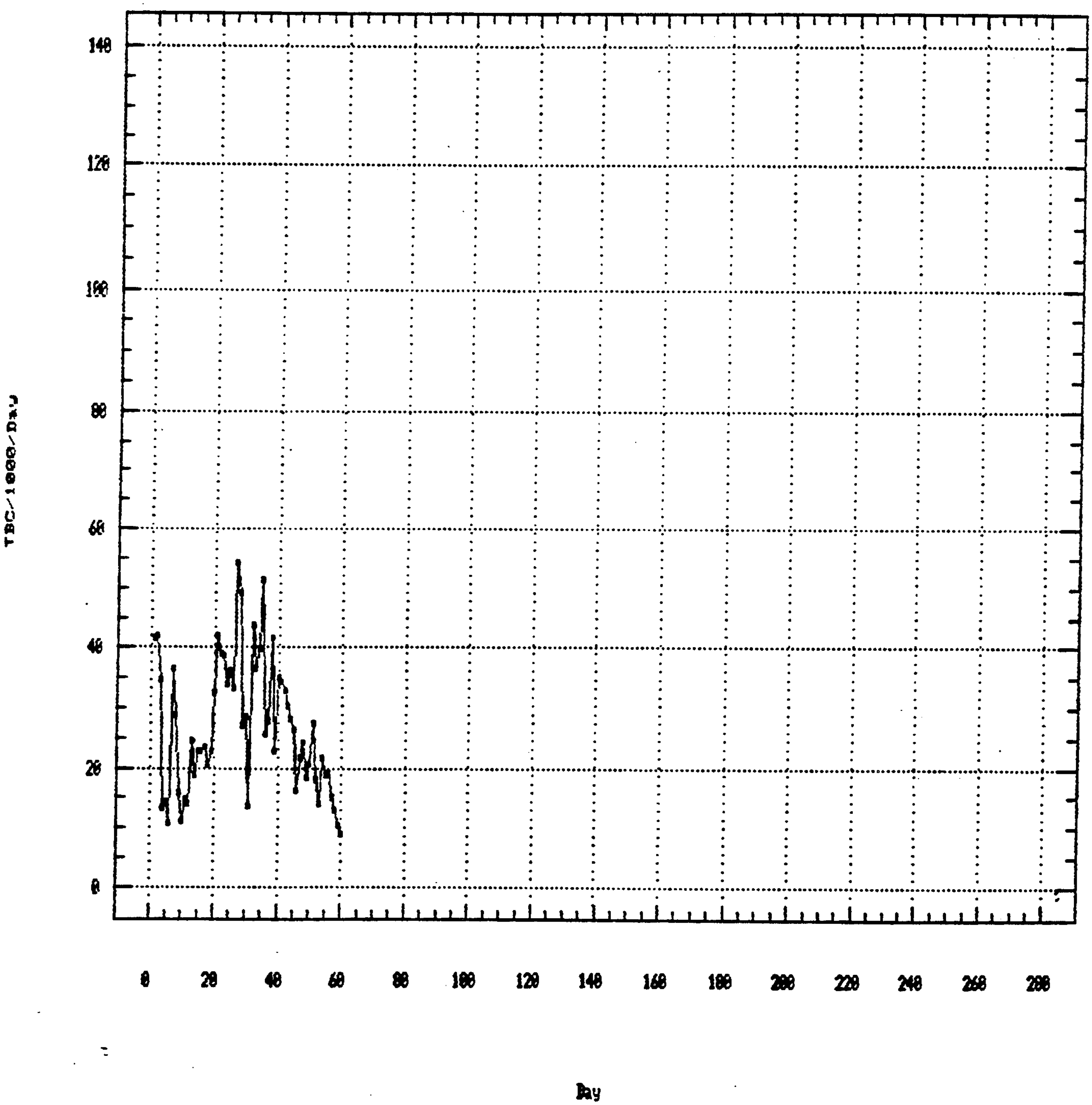
Army 4-2

(Average Daily Division-level Rate)



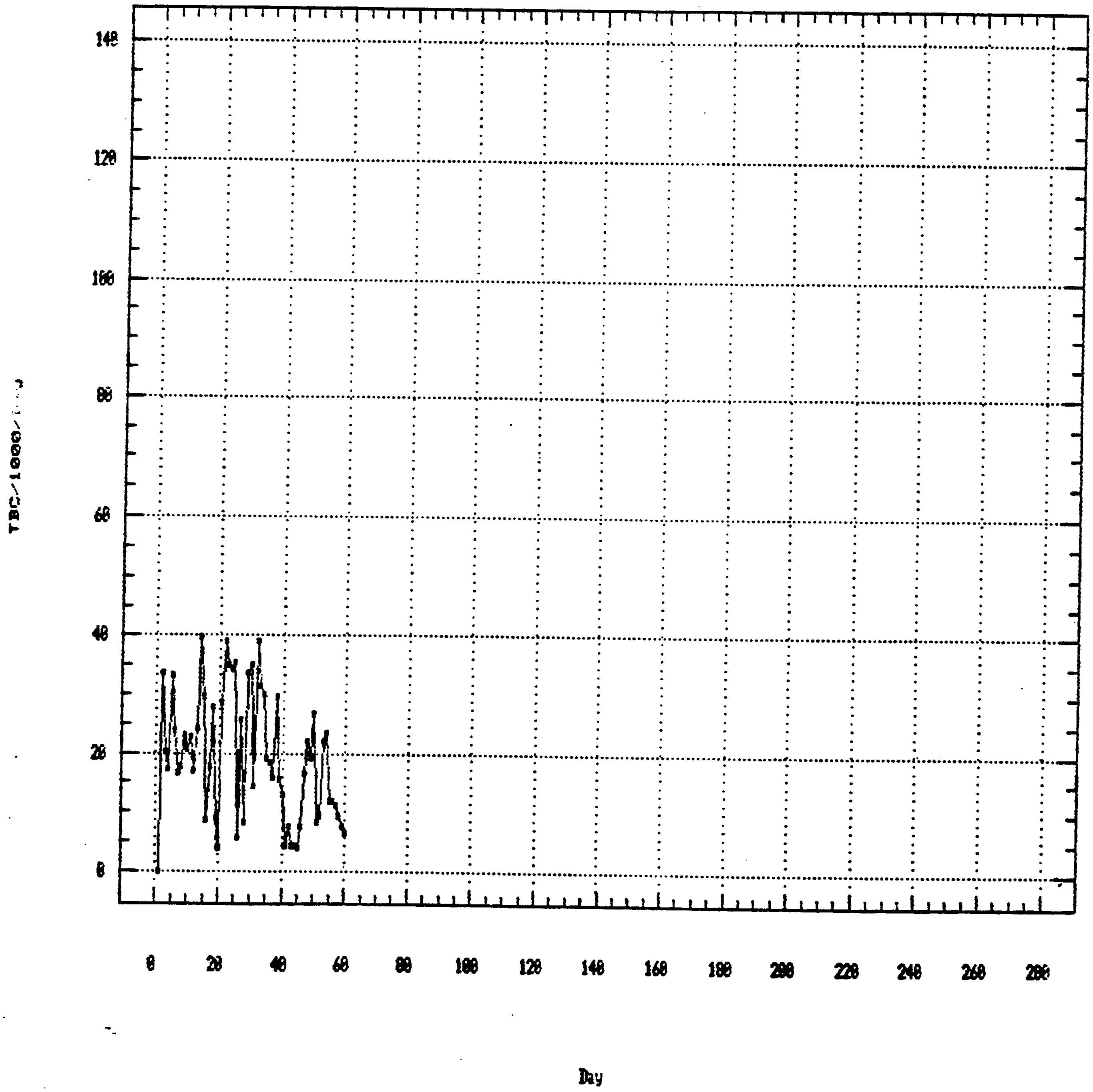
Army 4-3

(Average Daily Division-level Rate)



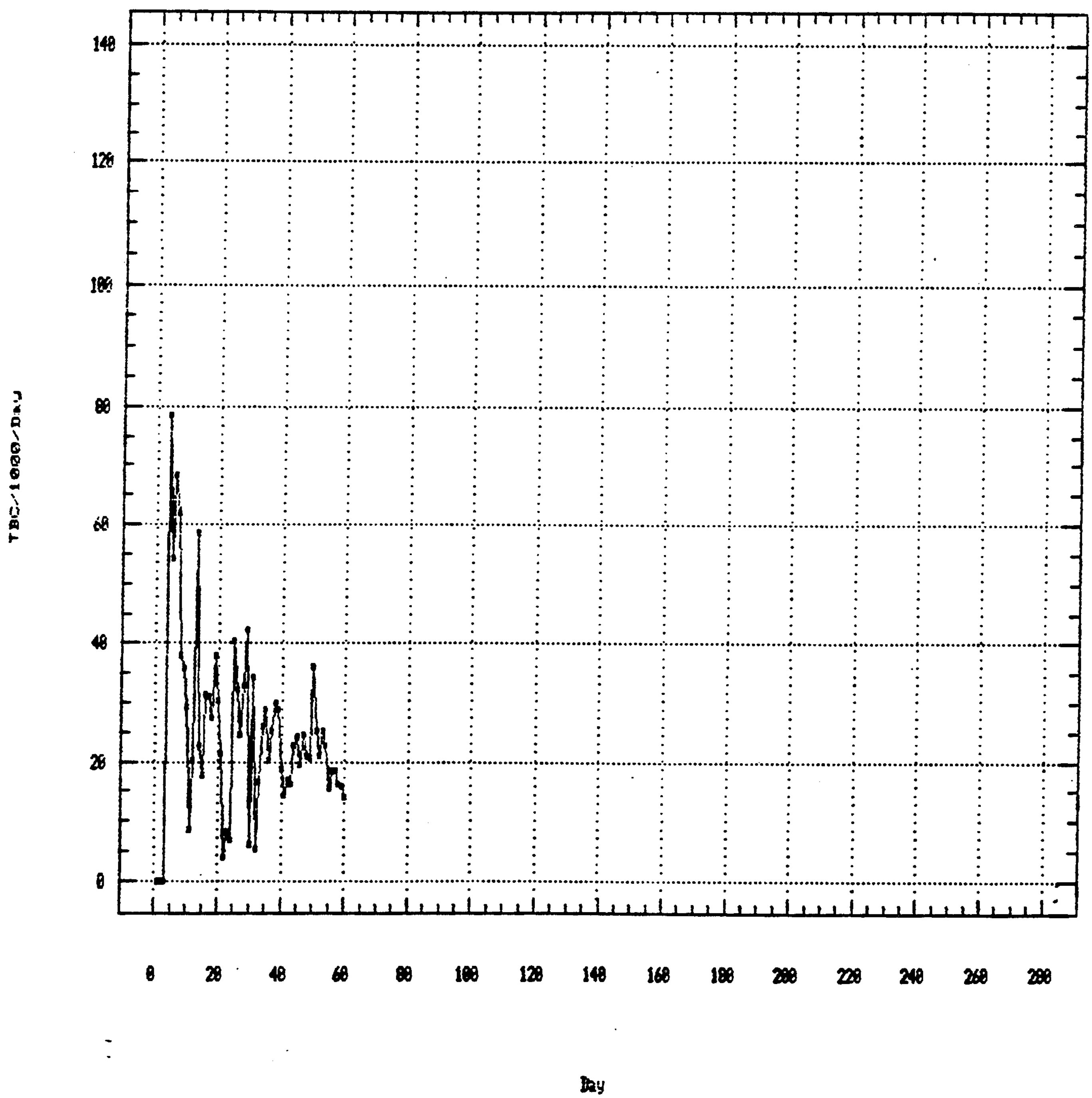
Army 4-4

(Average Daily Division-level Rate)



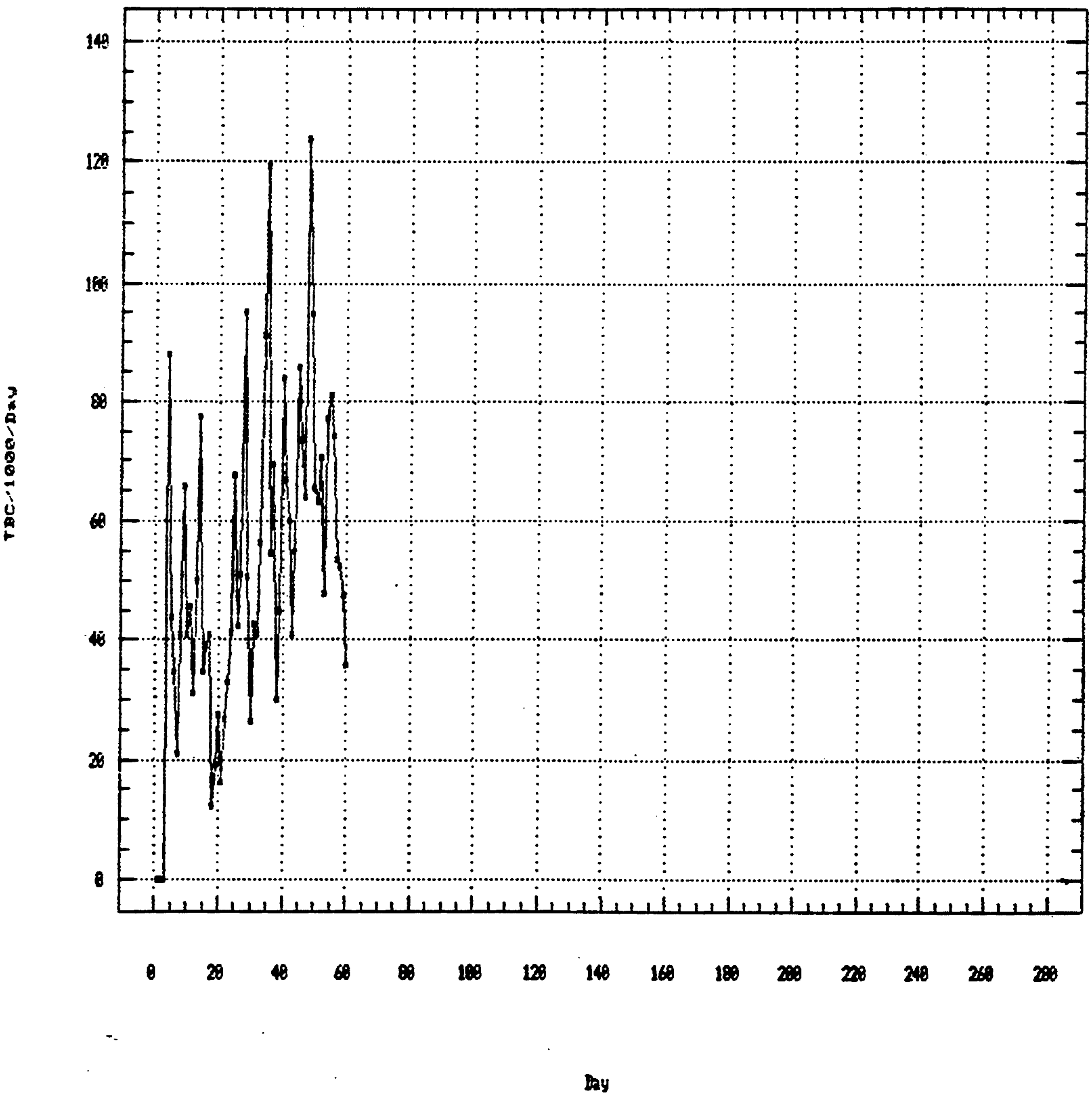
'Created Army 1'

(Average Daily Division-level Rate)



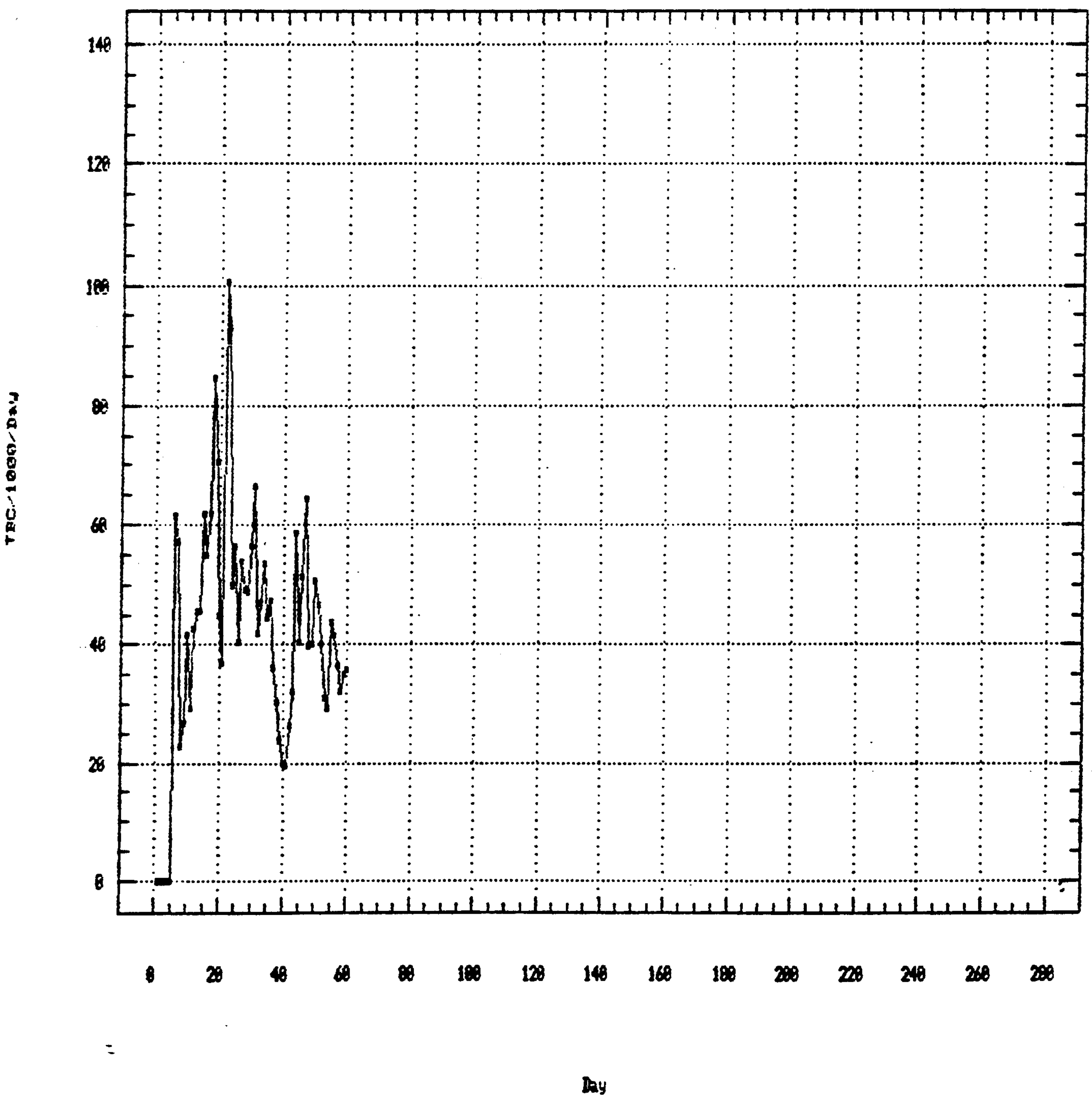
'Created Army 2'

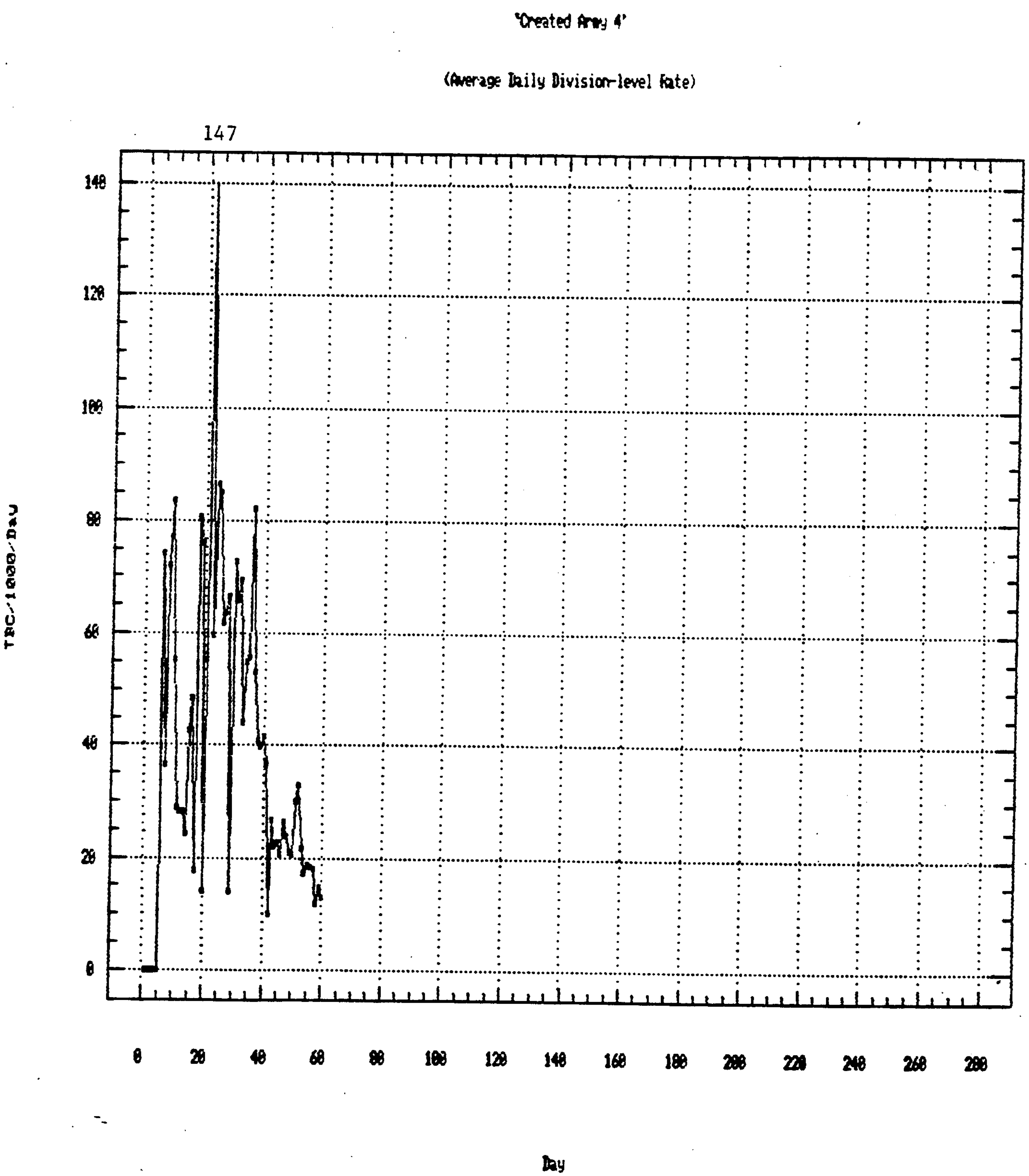
(Average Daily Division-level Rate)



'Created Army 3'

(Average Daily Division-level Rate)

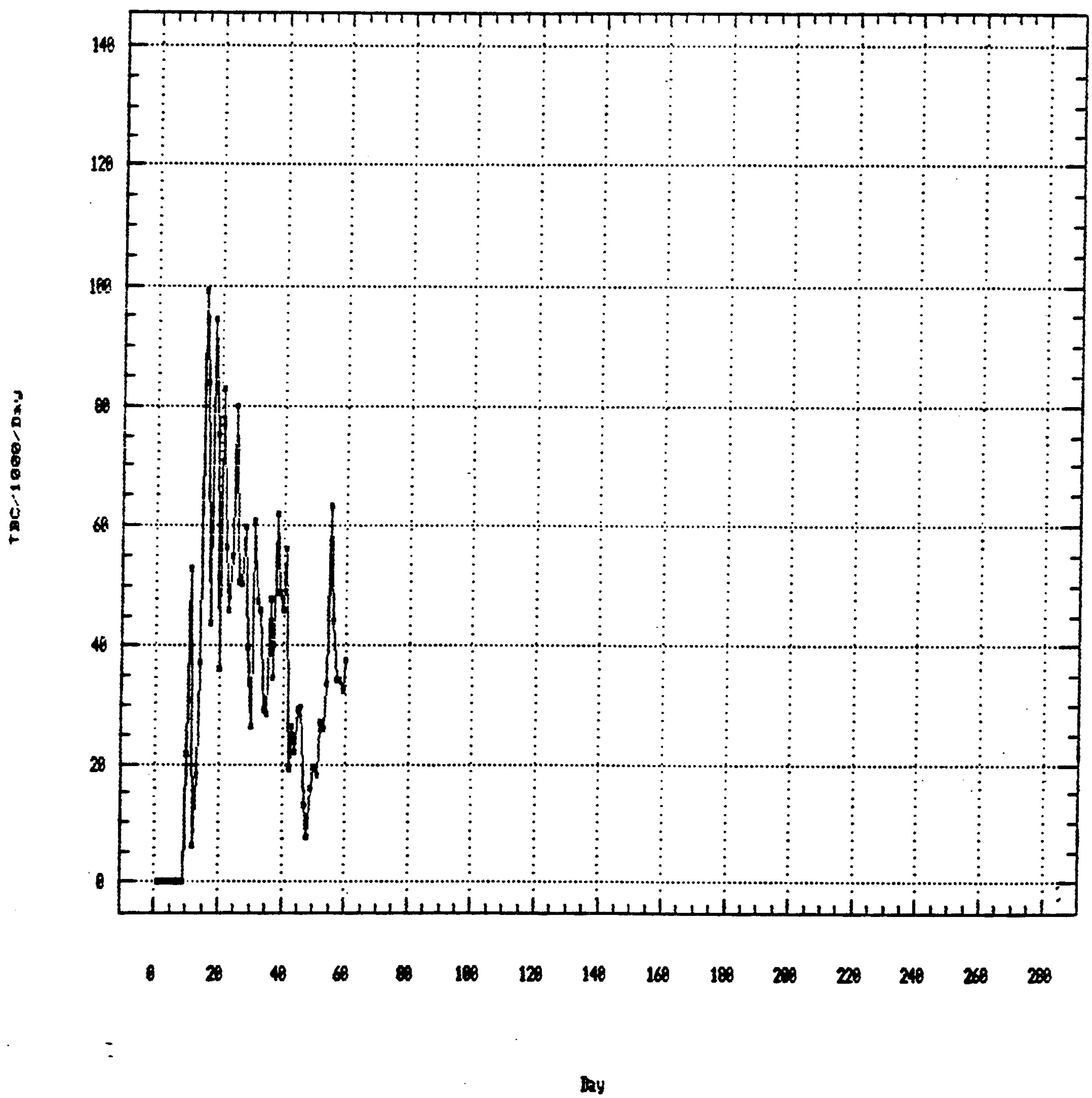


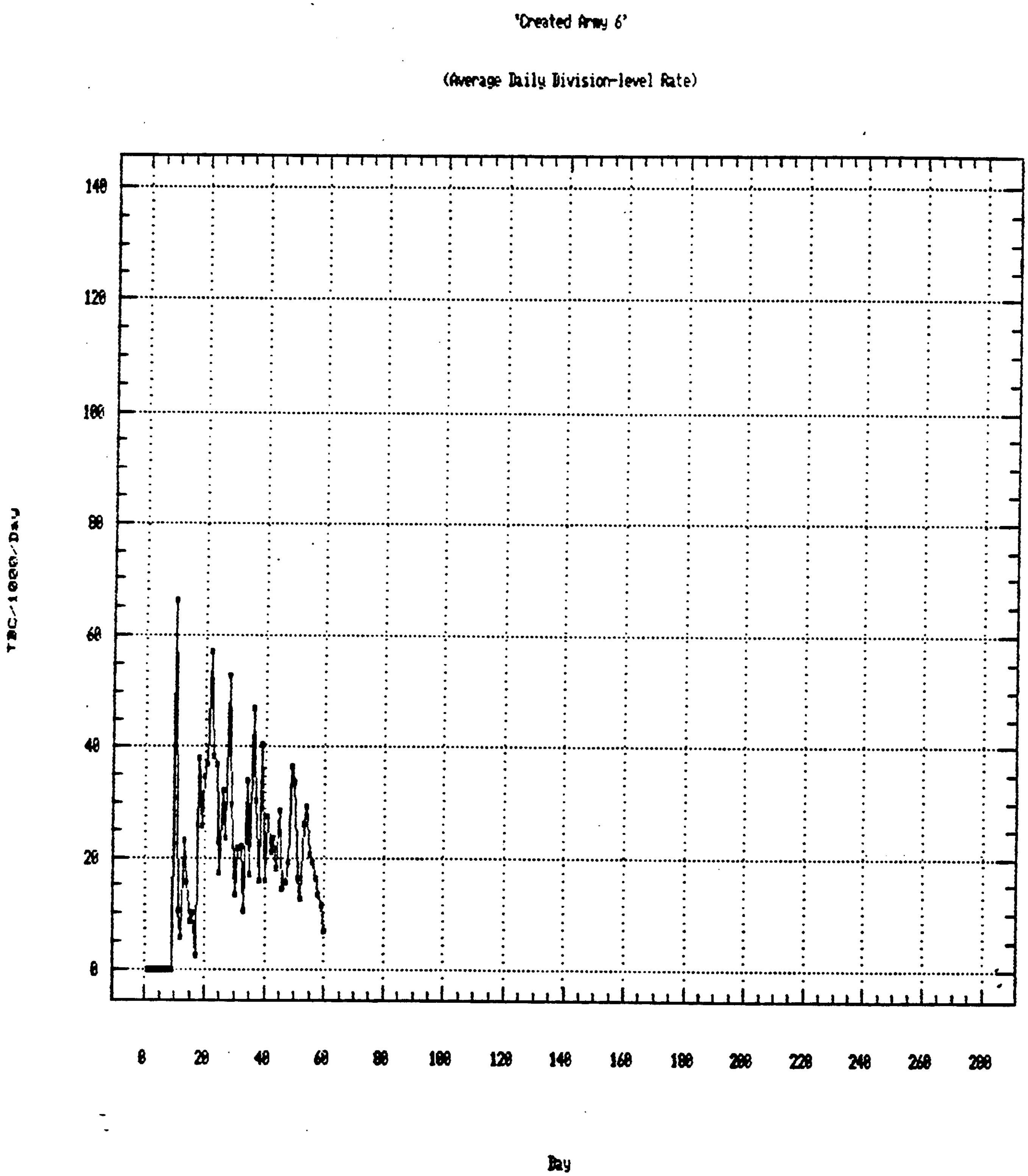


'Created Army 4'
(Average Daily Division-level Rate)
147
TBC/1000/Day
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

'Created Army 5'

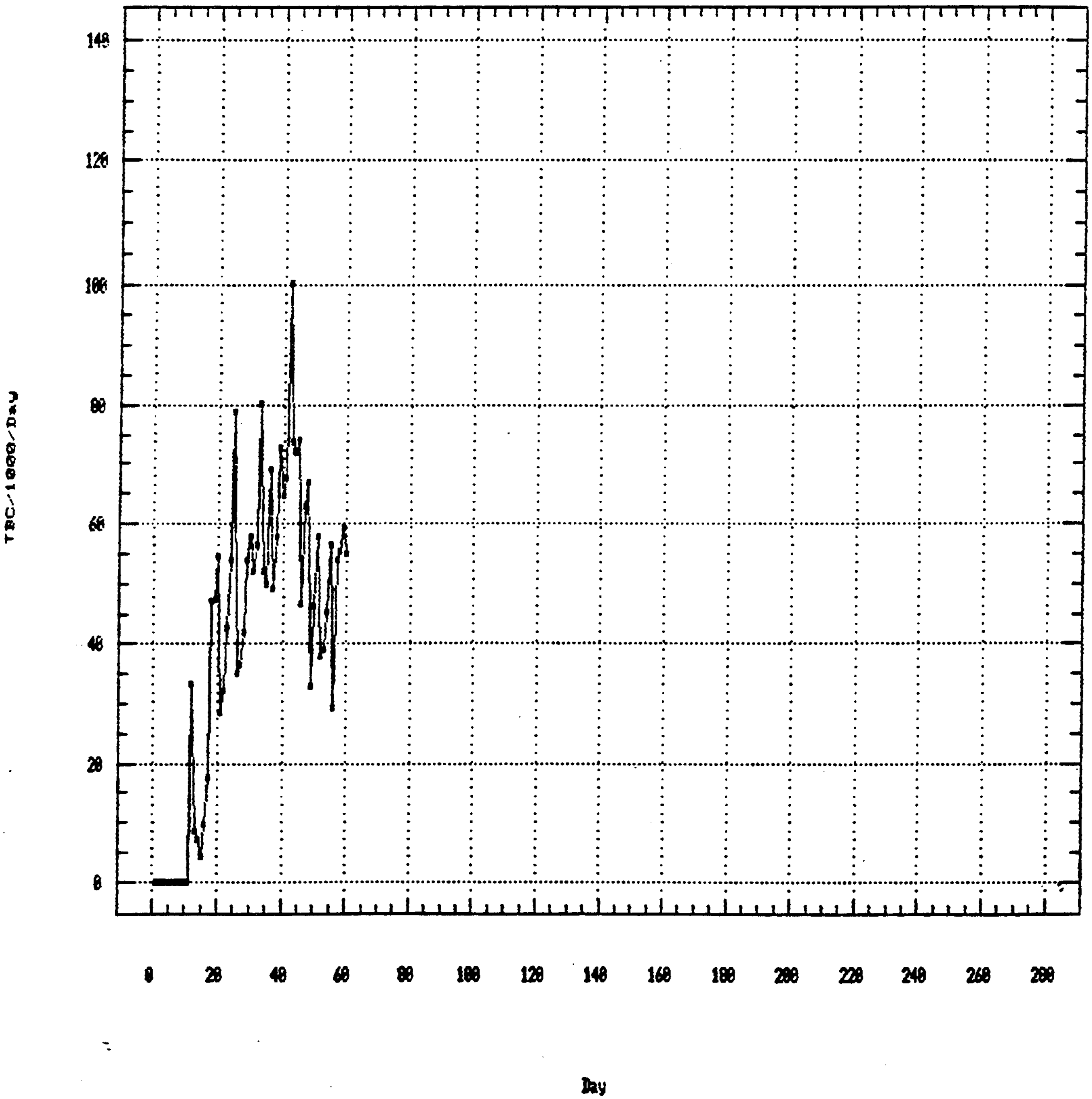
(Average Daily Division-level Rate)




'Created Army 6'
(Average Daily Division-level Rate)
TBC/1000/Day
140
120
100
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Day

'Created Army 7'

(Average Daily Division-level Rate)



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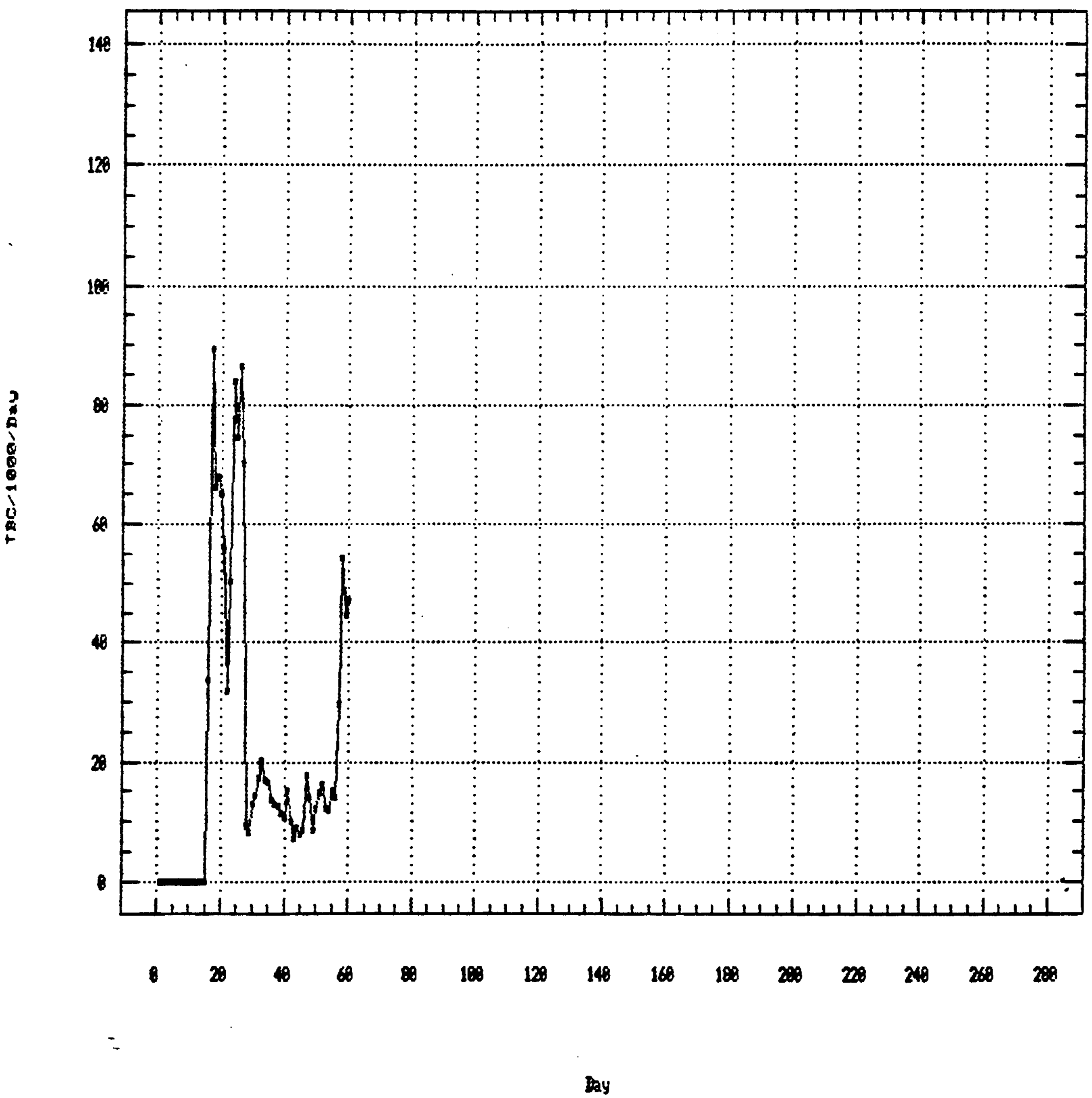
(Average Daily Division-level Rate)



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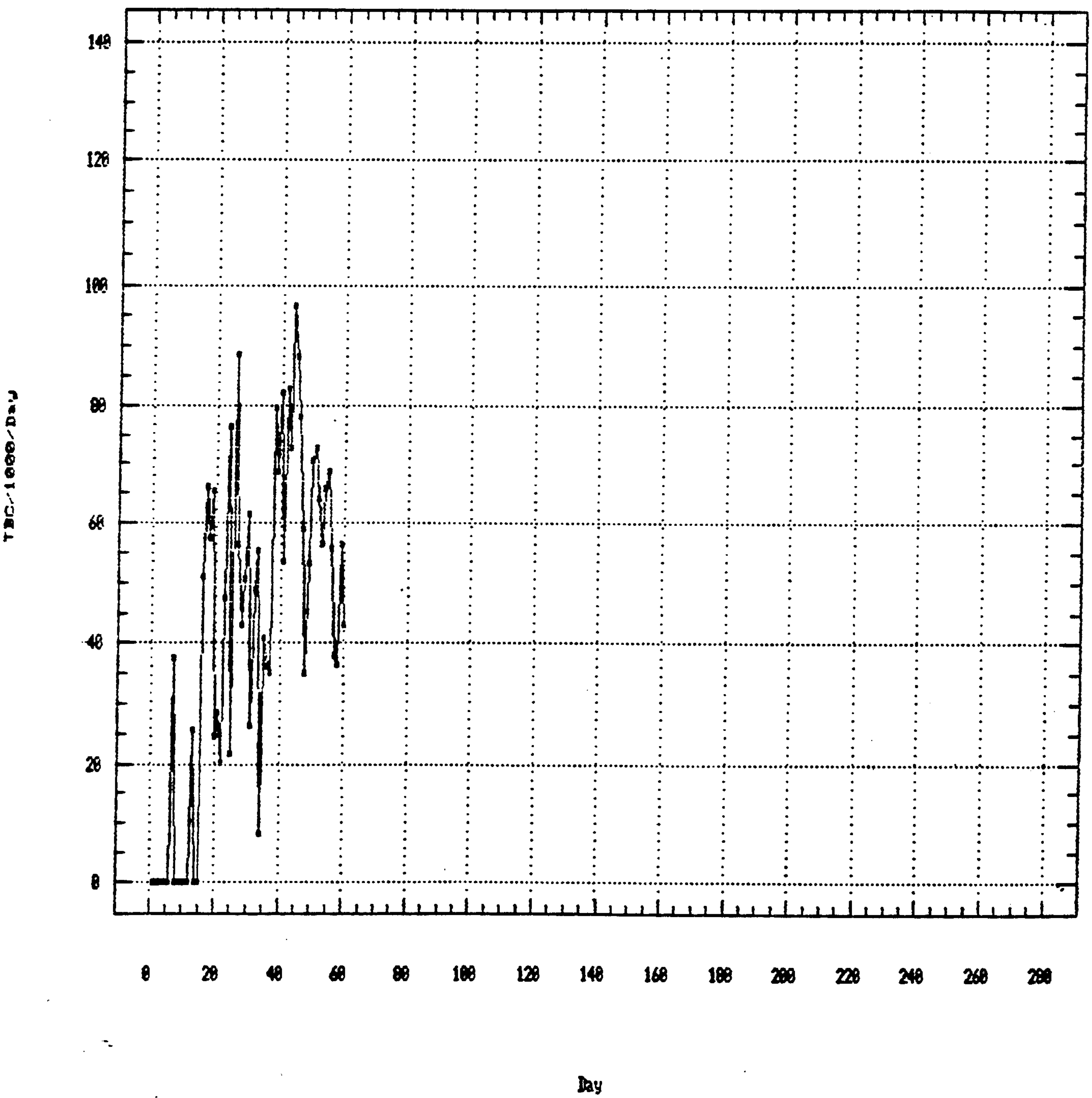
(Average Daily Division-level Rate)



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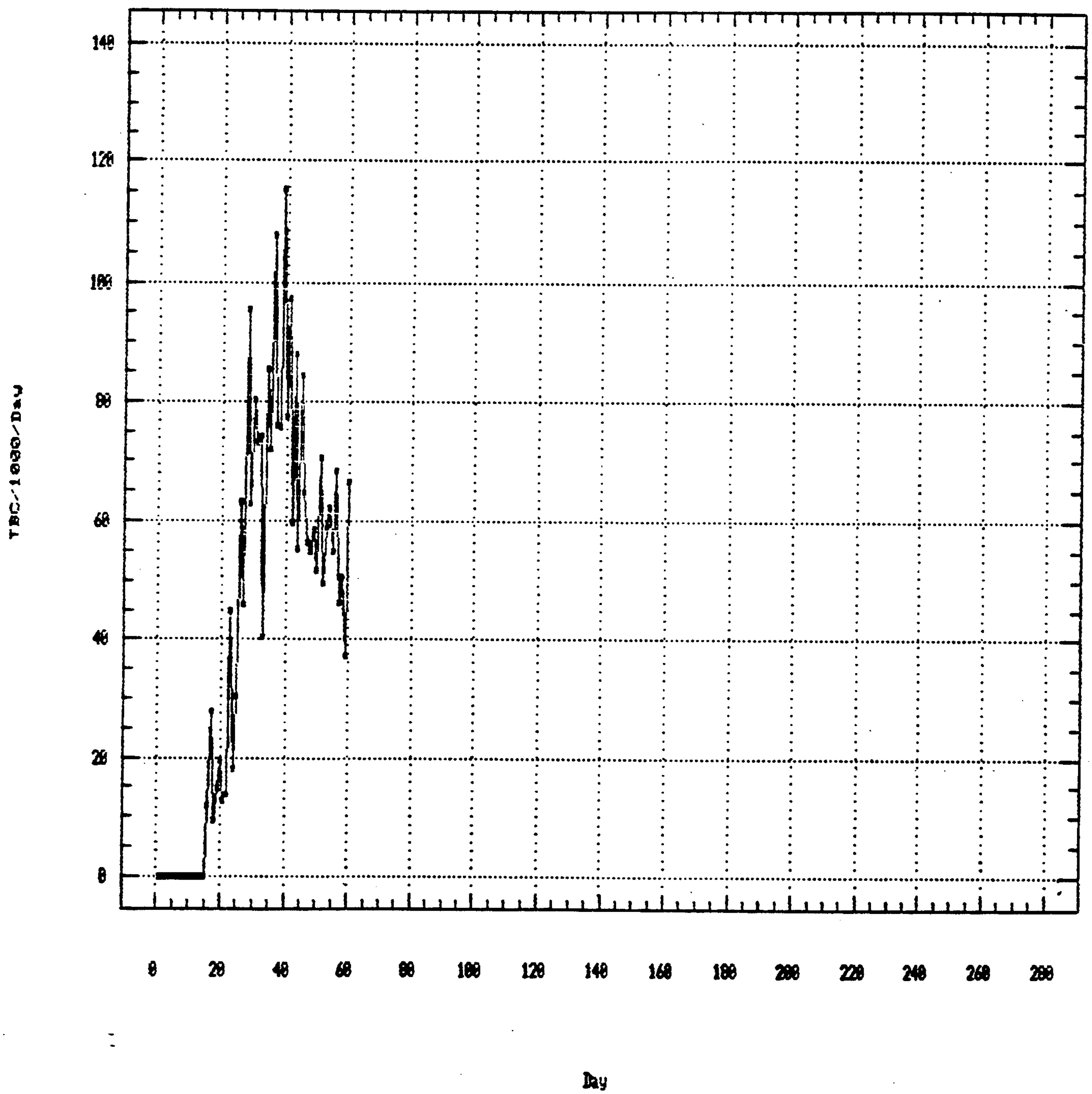
(Average Daily Division-level Rate)



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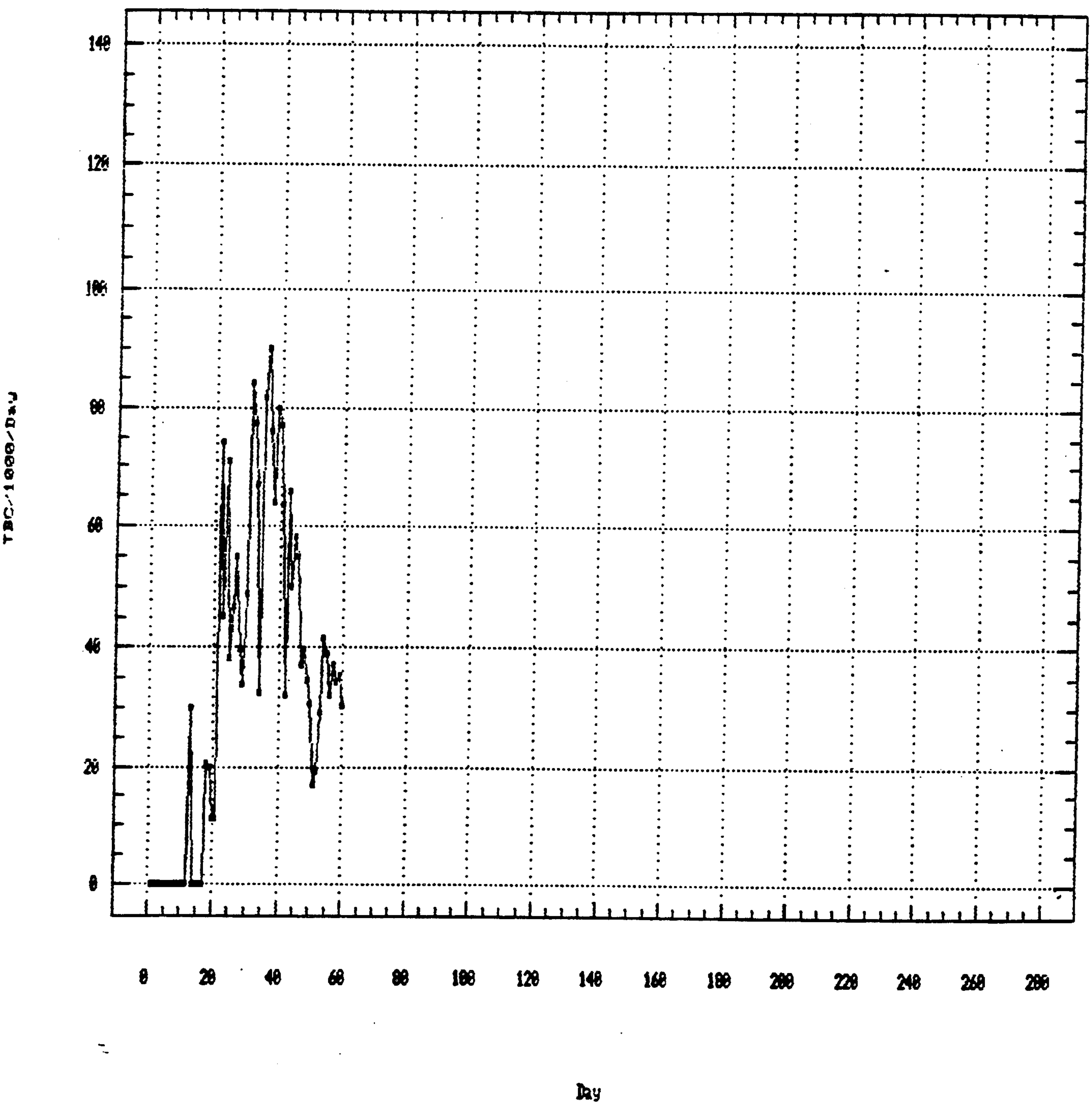
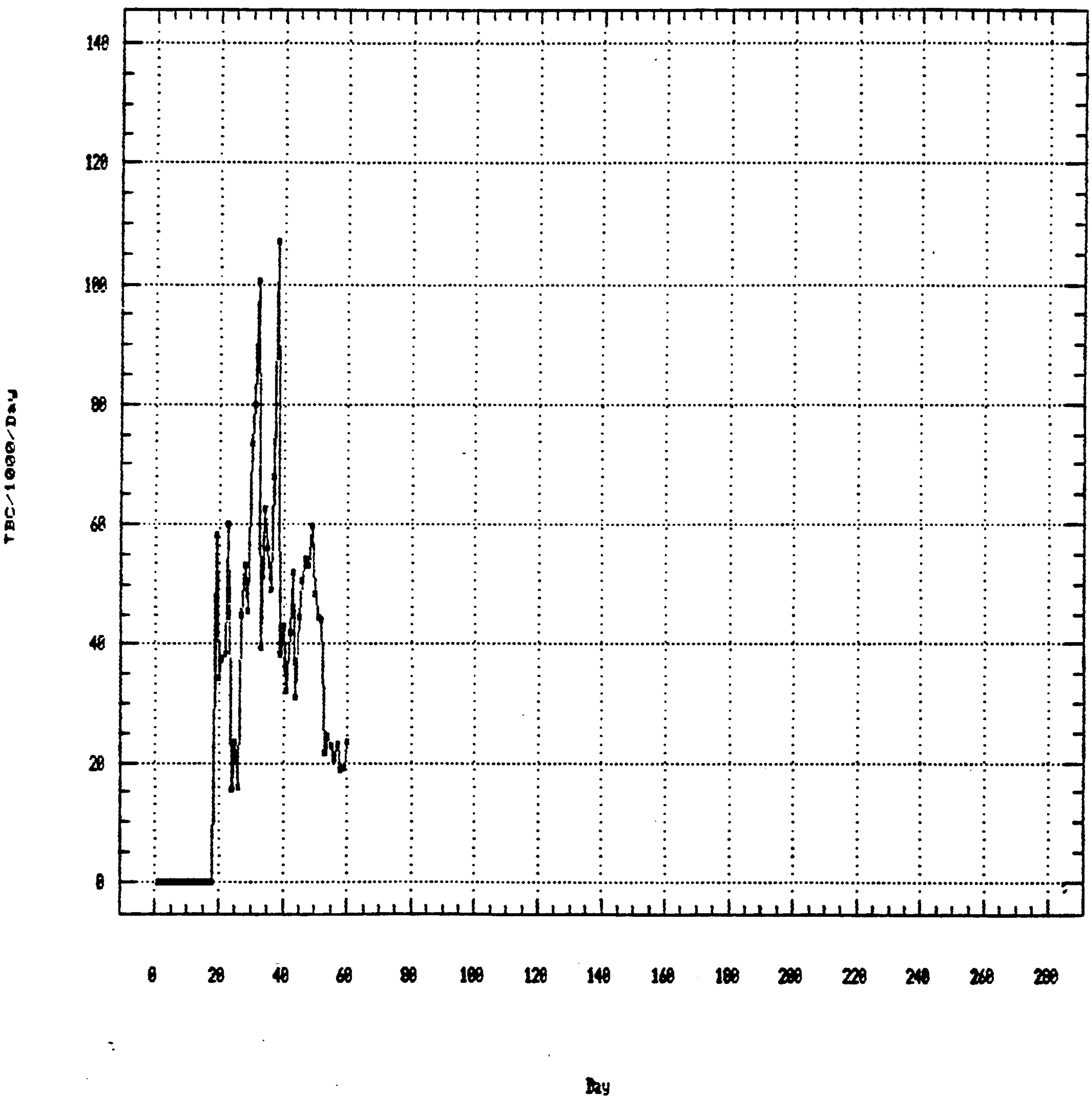
(Average Daily Division-level Rate)



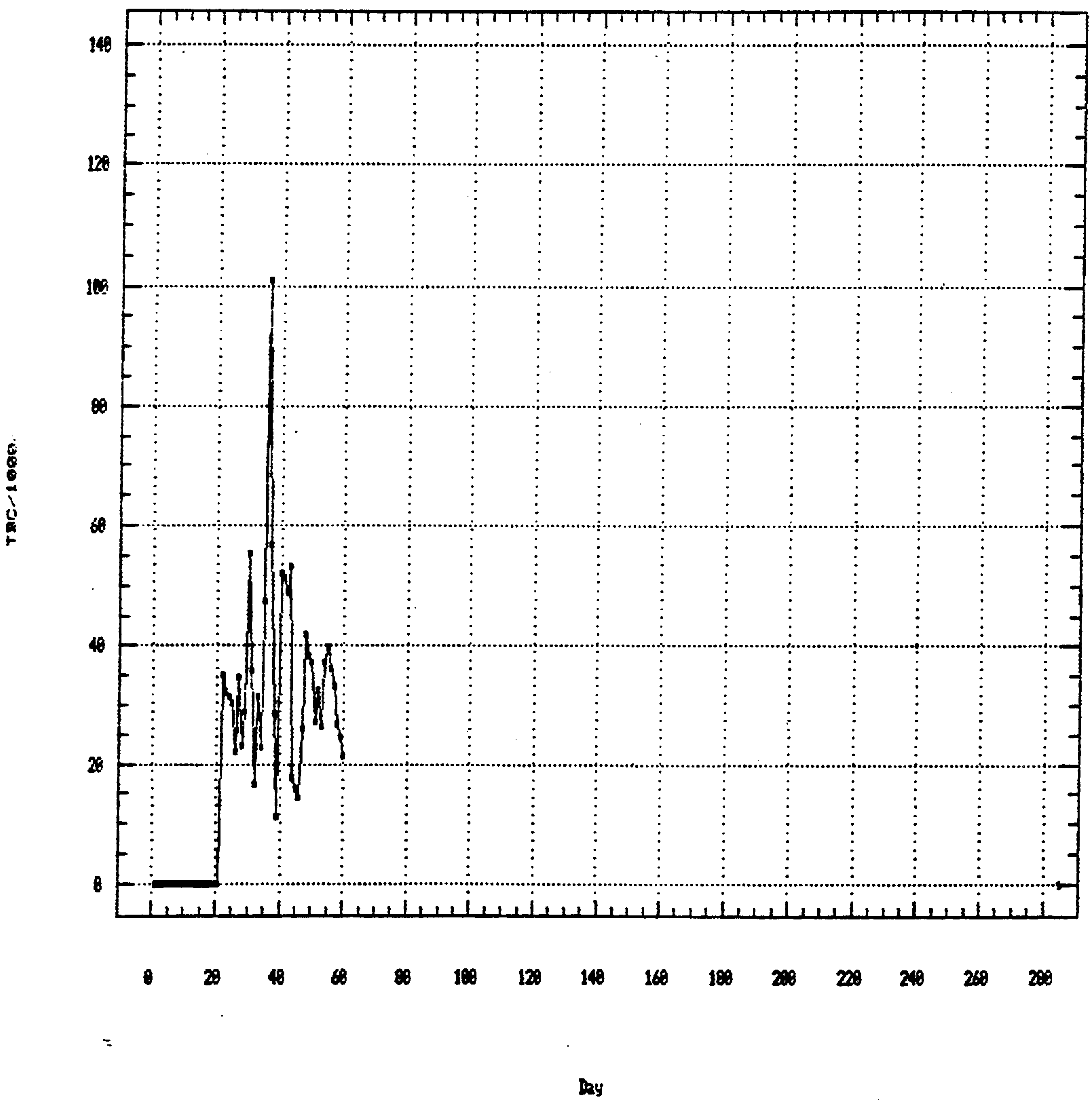
'Created Army 12'

(Average Daily Division-level Rate)



'Created Army 13'

(Average Daily Division-level Rate)



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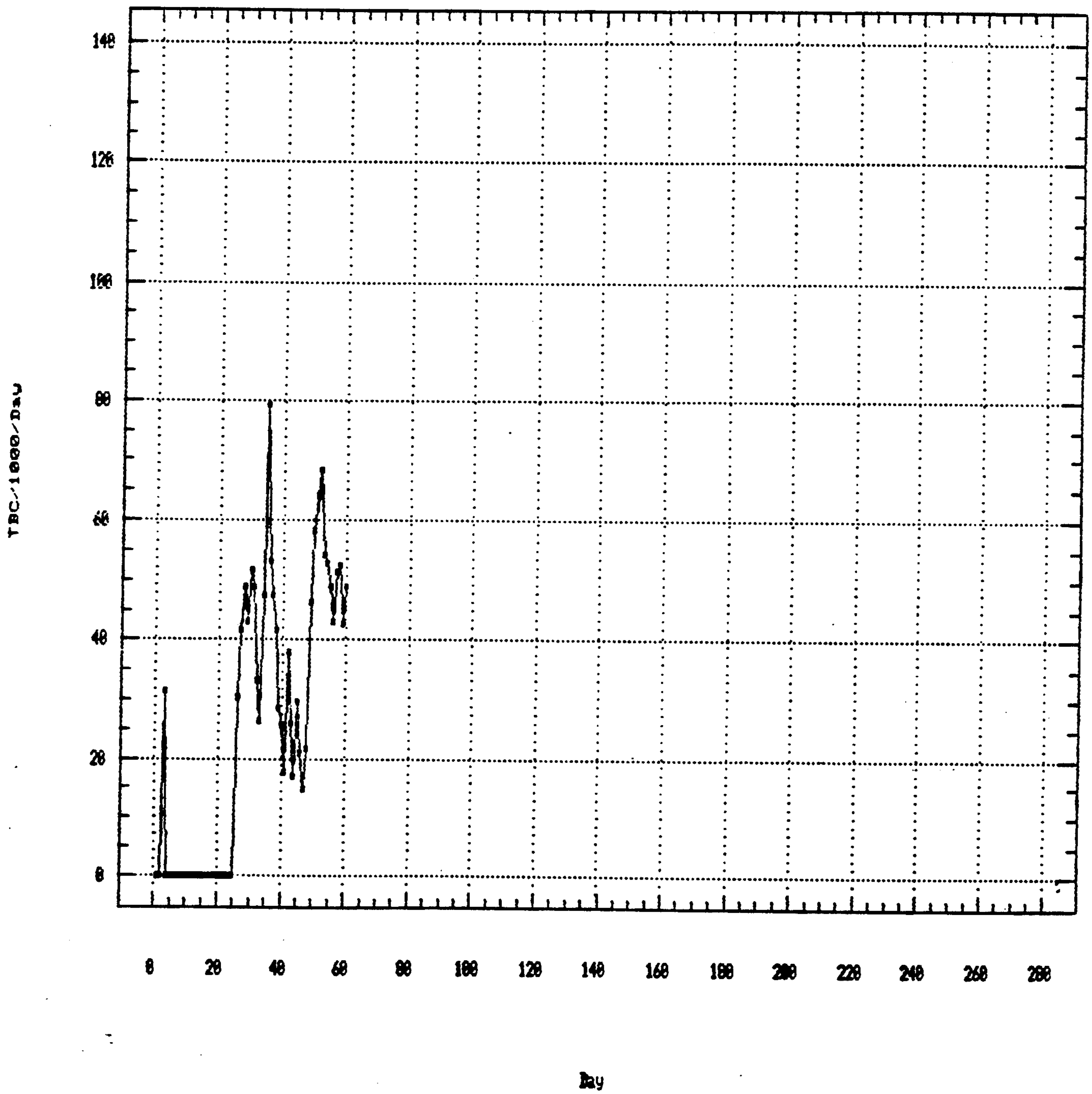

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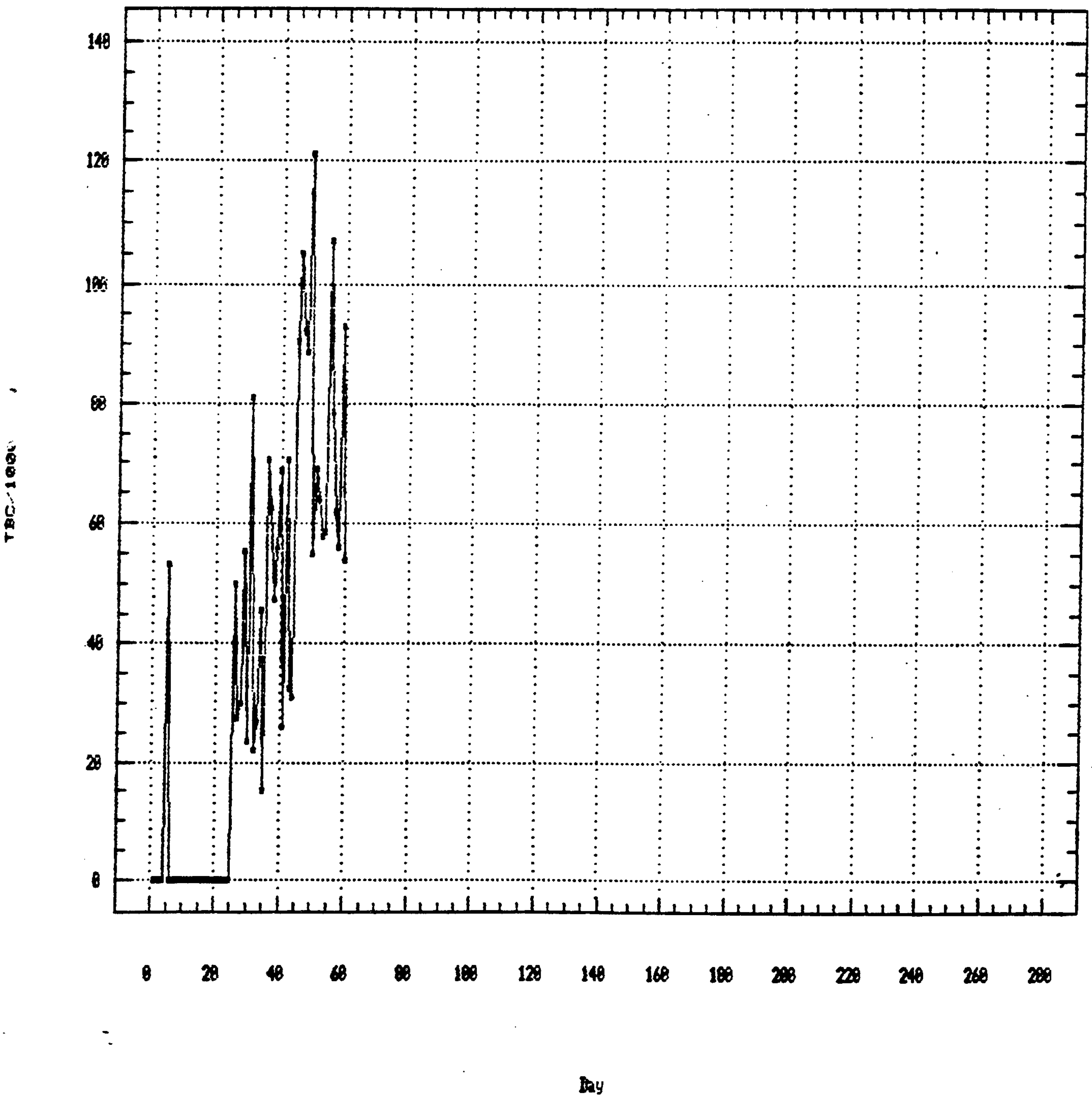

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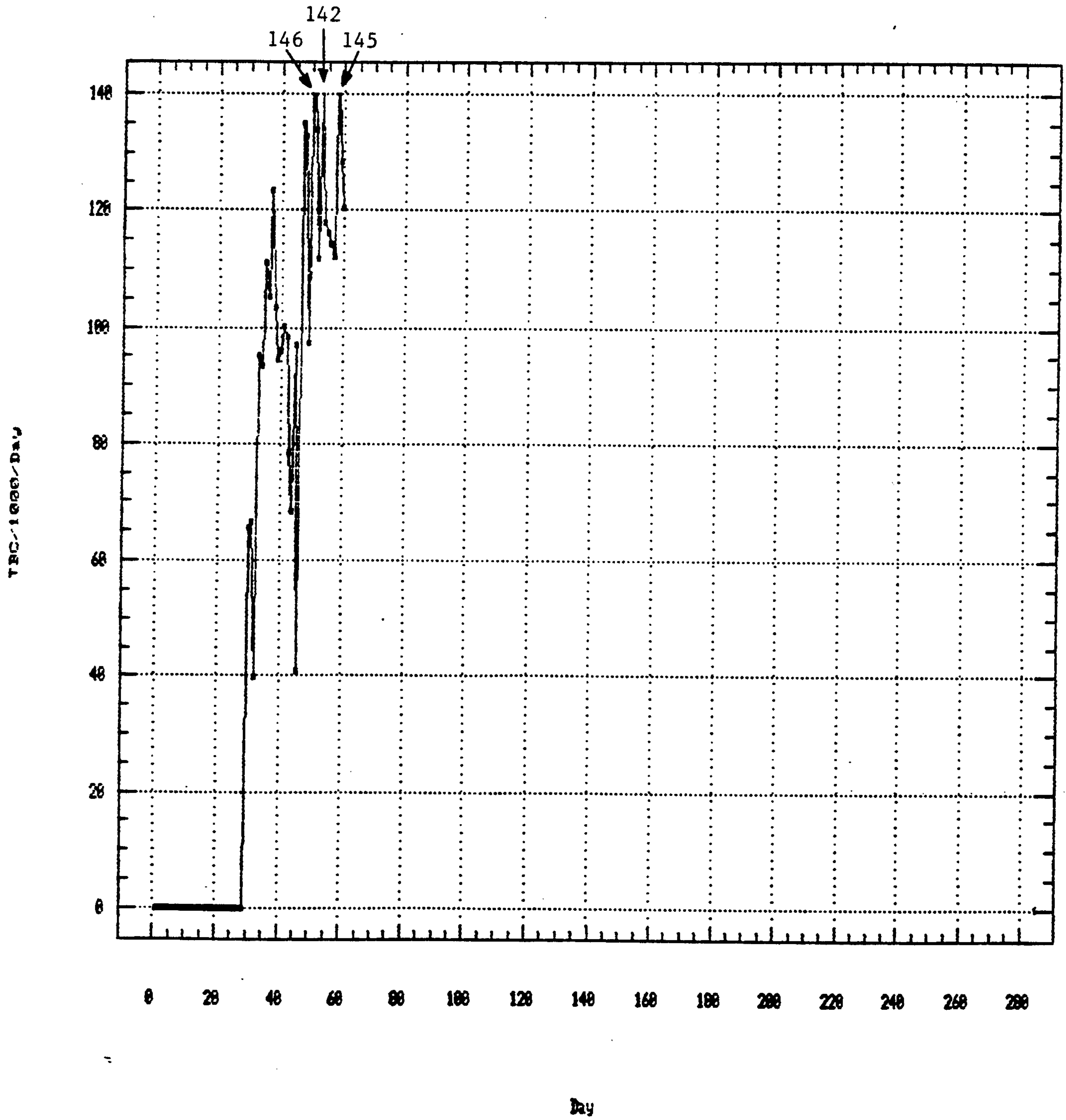

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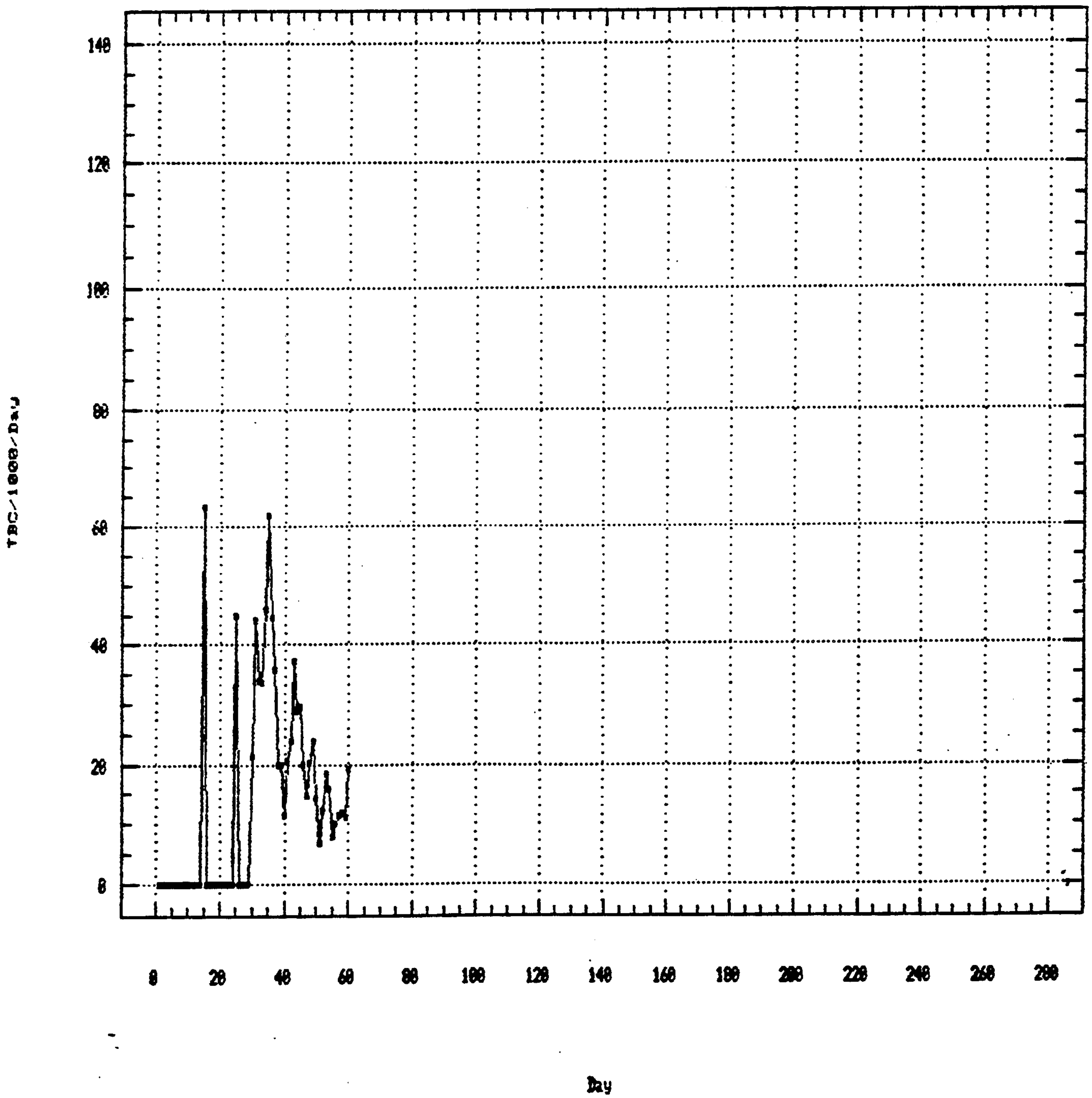

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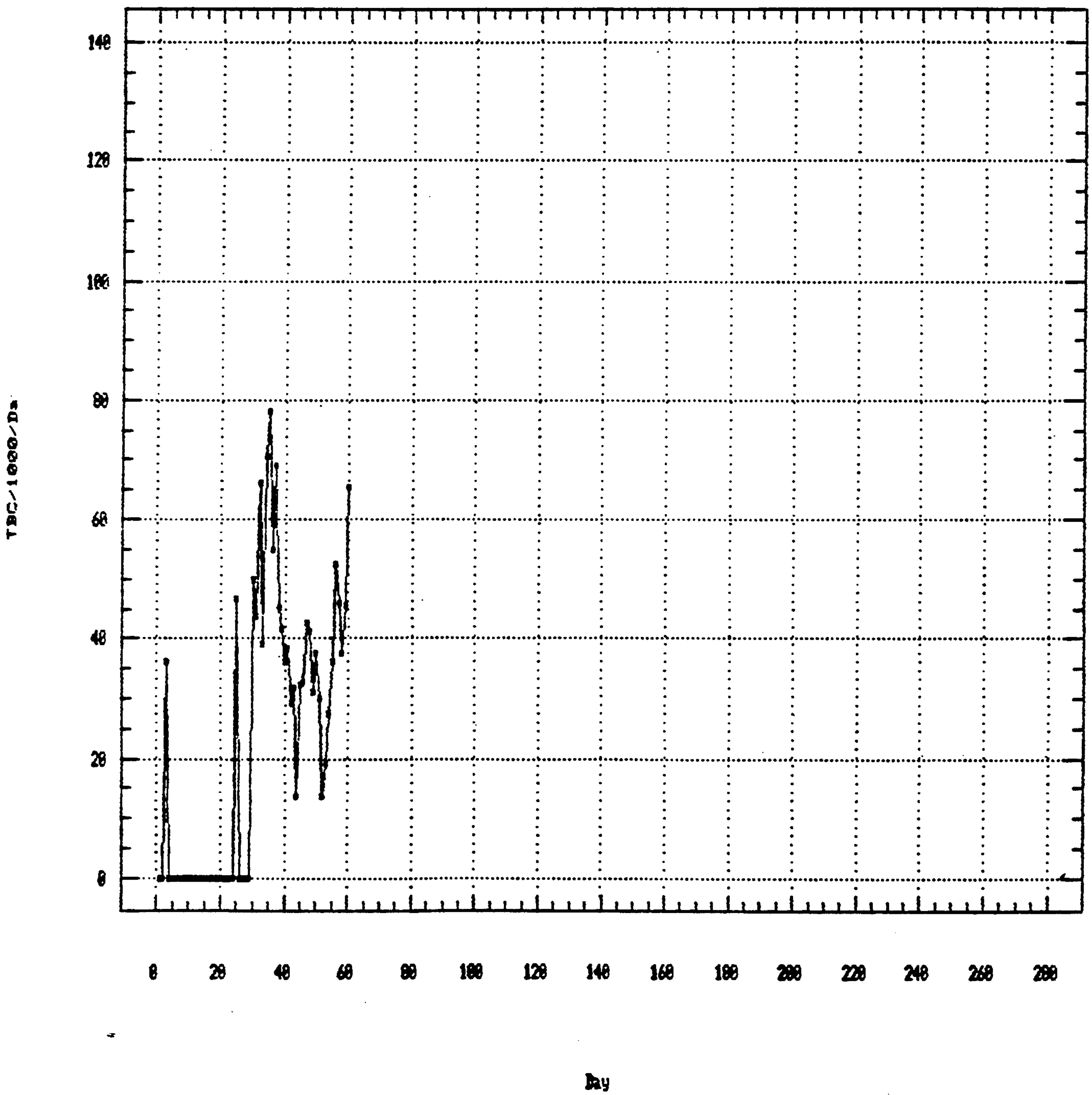

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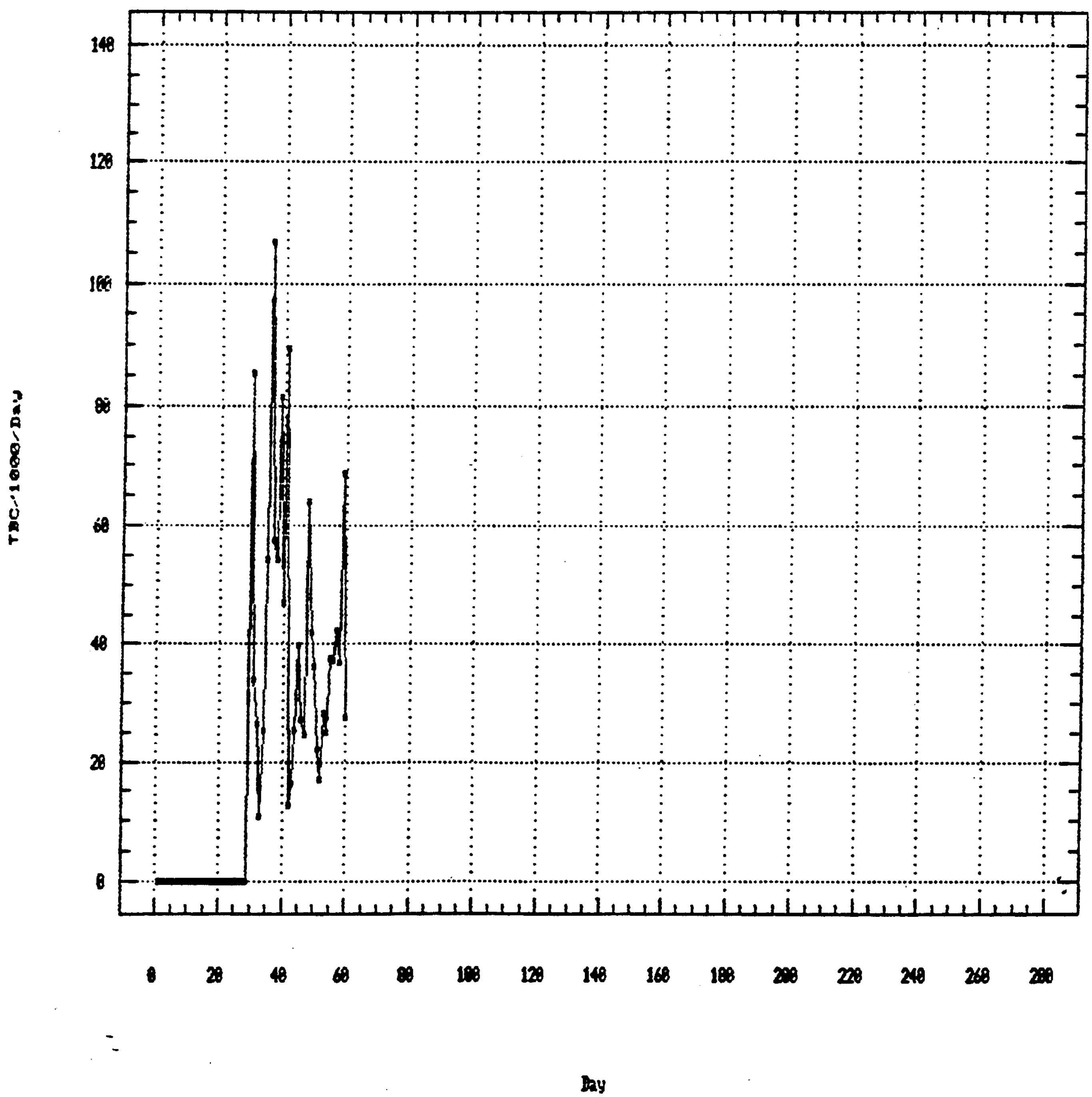

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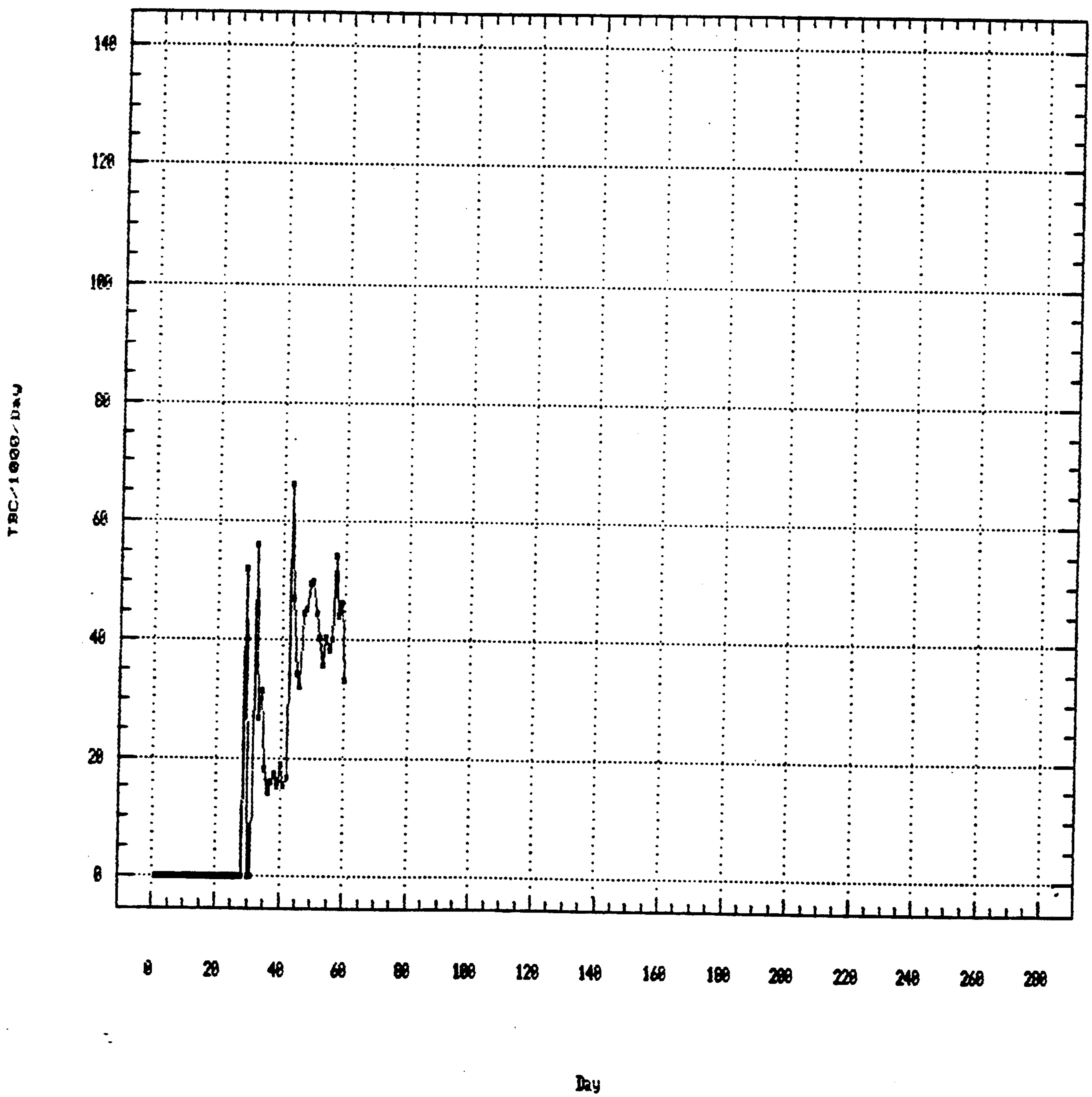
(Average Daily Division-level Rate)



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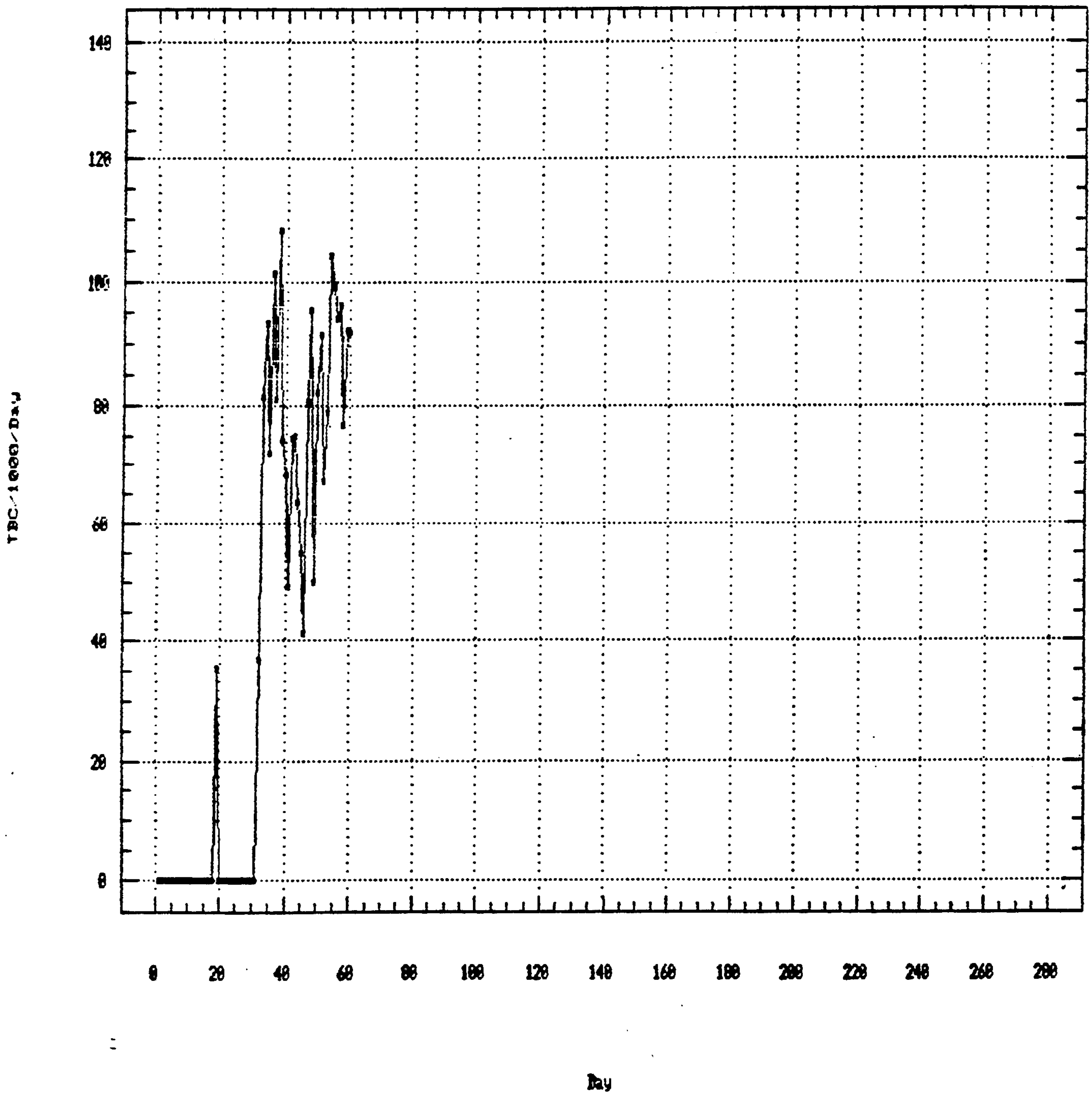
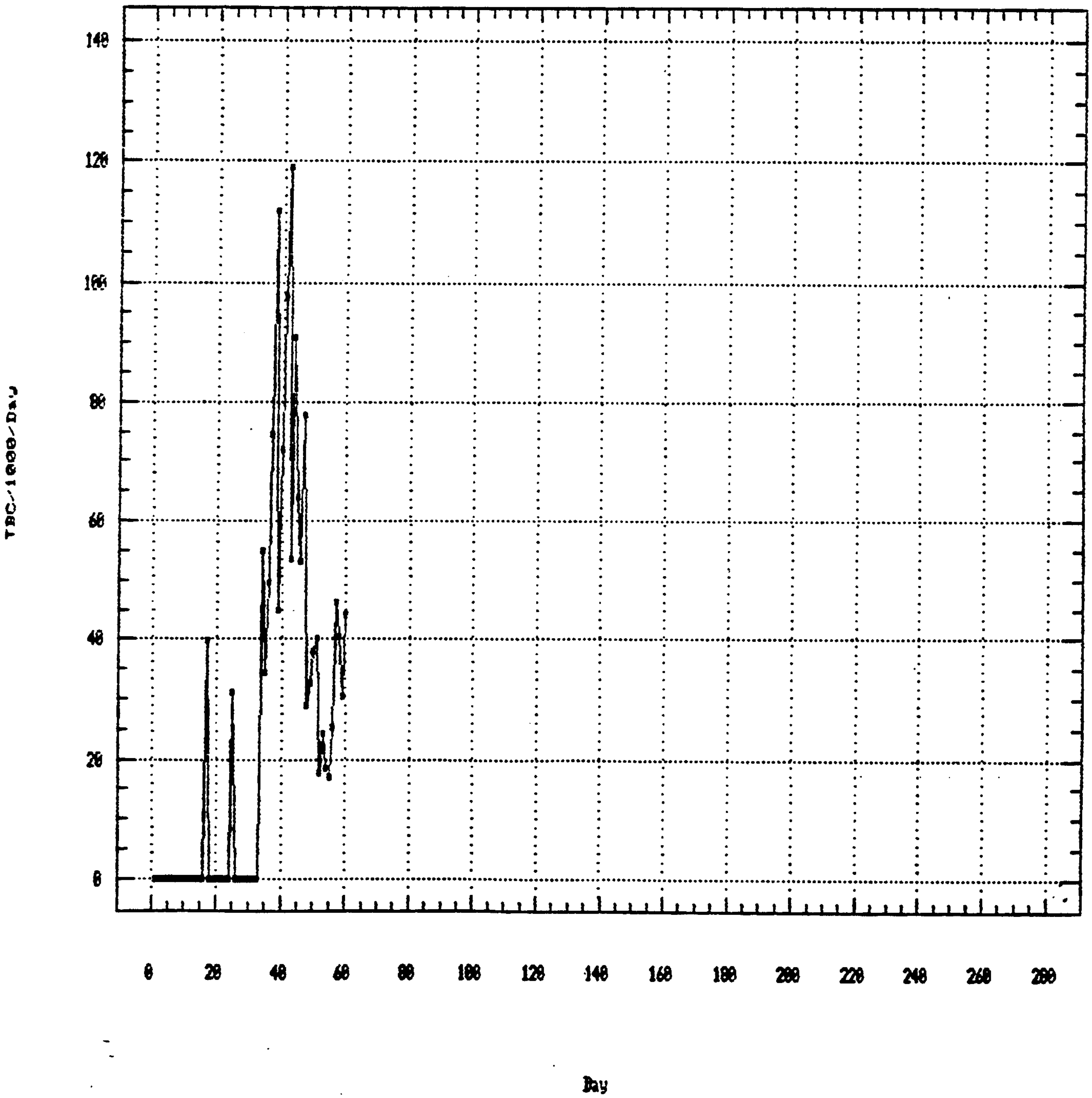
(Average Daily Division-level Rate)



"Created Army 22"

(Average Daily Division-level Rate)



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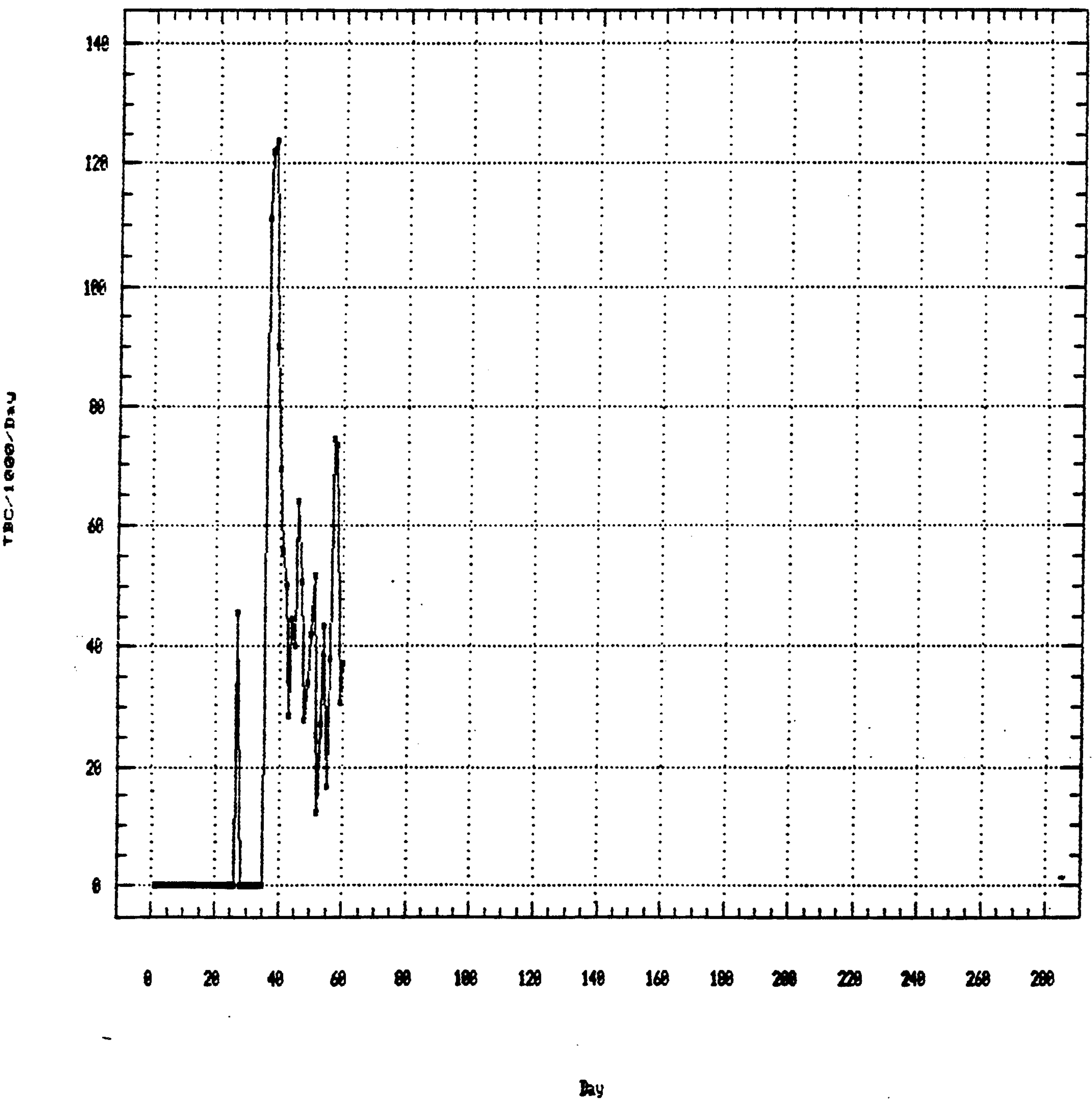
(Average Daily Division-level Rate)



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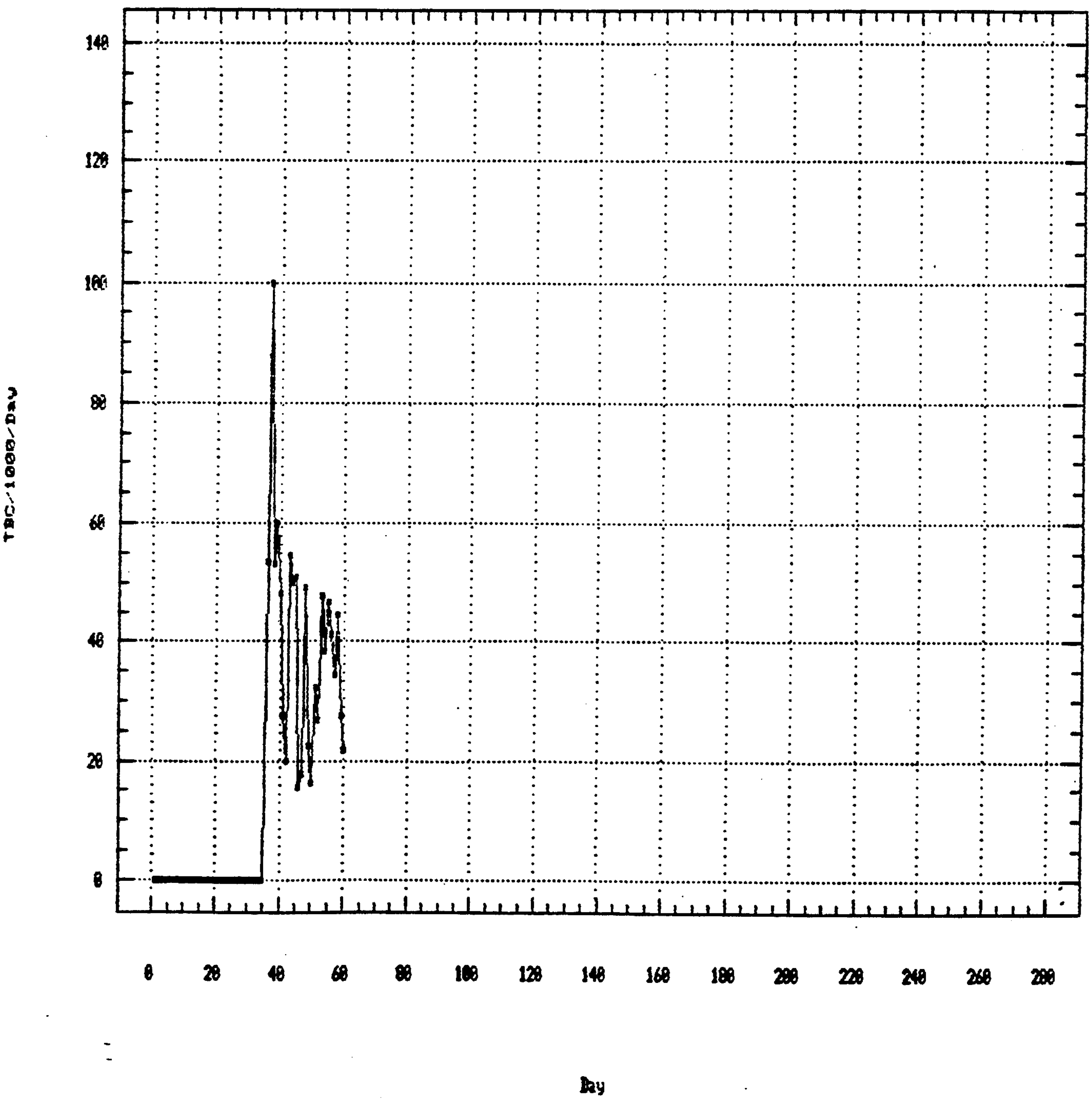

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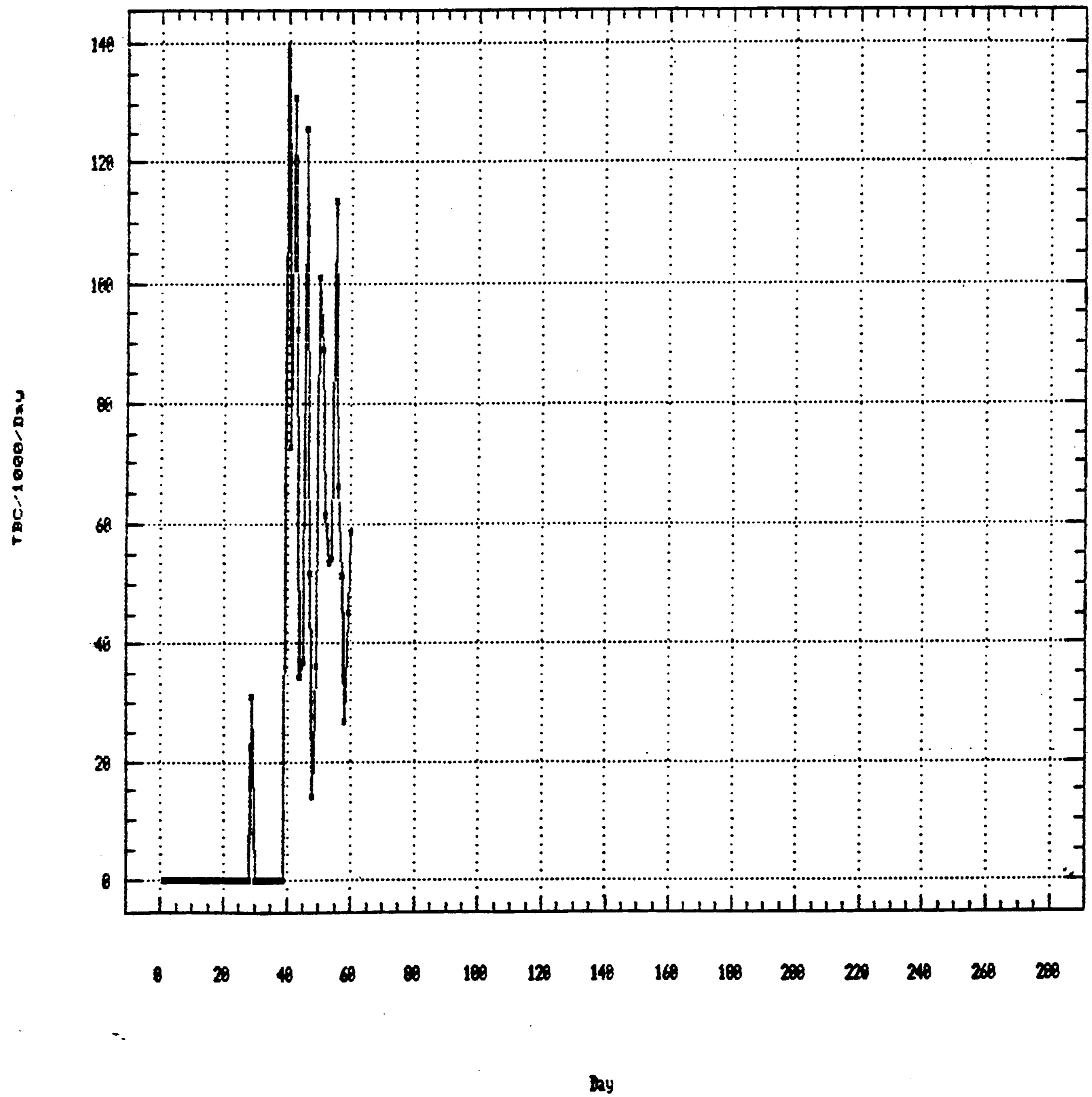
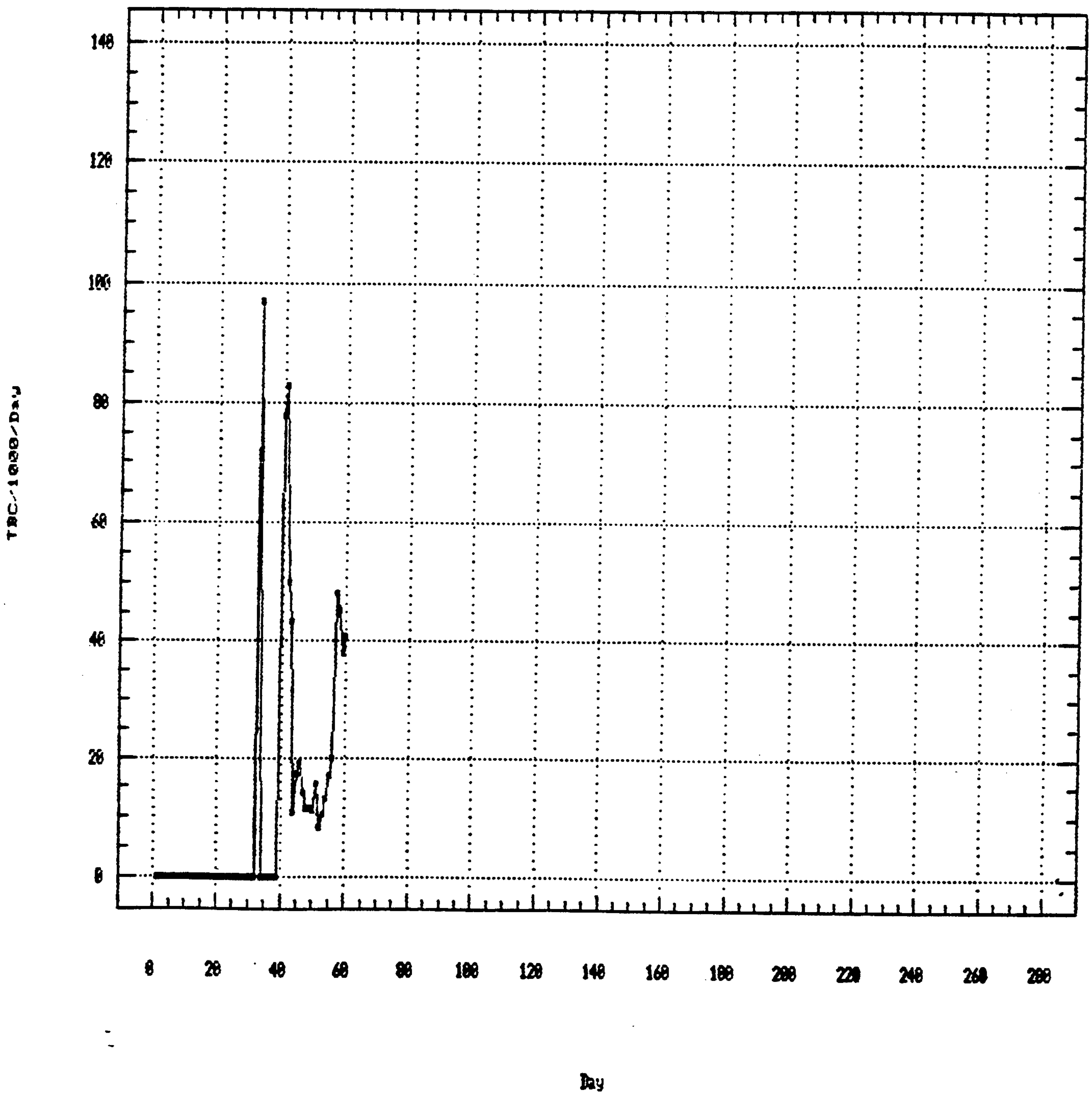
(Average Daily Division-level Rate)



'Created Army 26'

(Average Daily Division-level Rate)



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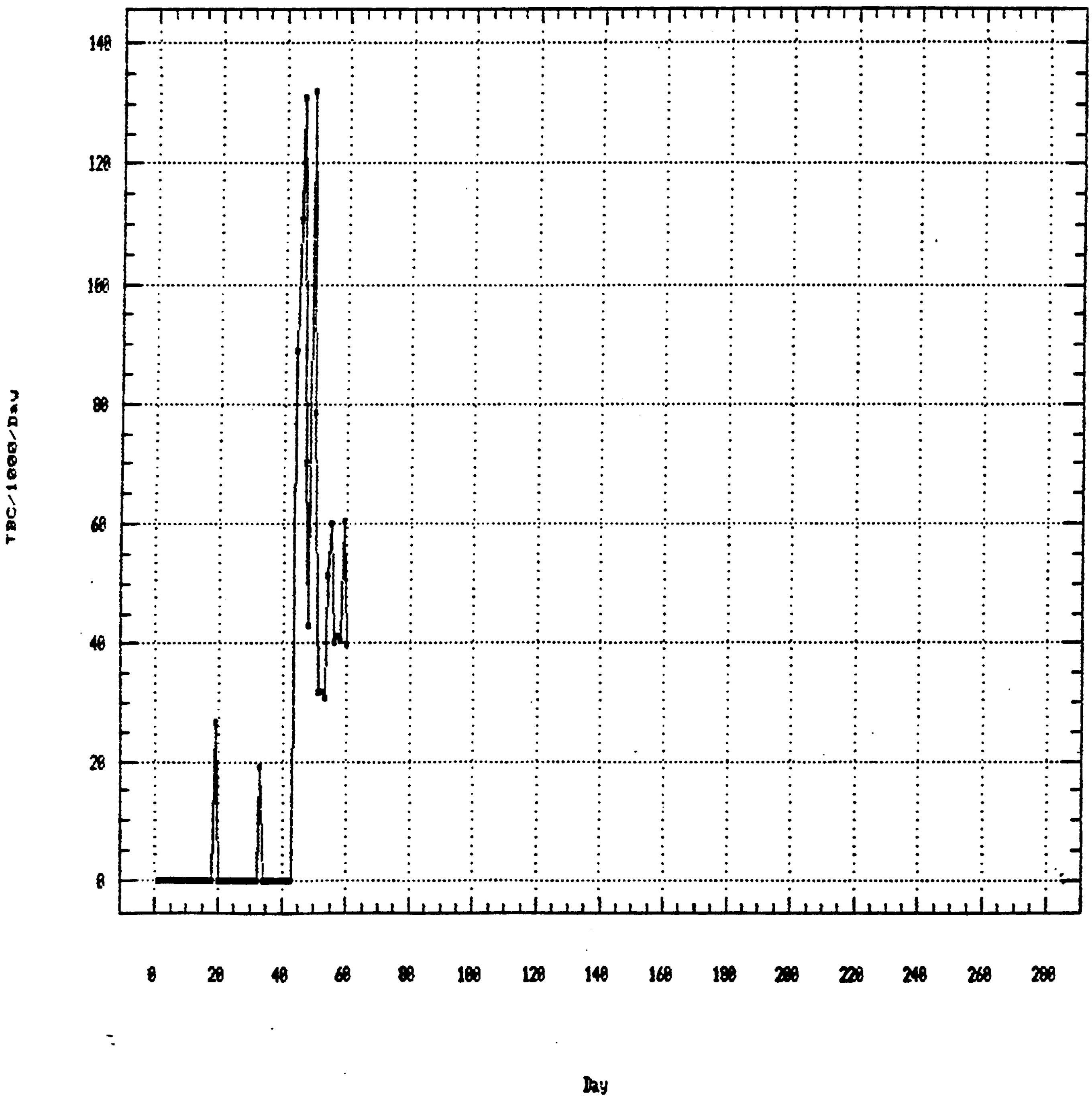

APPENDIX C

OUTLINE OF U.S. AND ALLIED CASUALTY RATE PROJECTIONS

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OUTLINE OF U.S. AND ALLIED CASUALTY RATE PROJECTIONS

This appendix briefly illustrates and discusses certain projected casualty rates that have been used in U.S. and Allied planning.

The appendix is classified SECRET and bound separately. It contains NATO classified information and foreign government information. It is available upon request to:

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OASD(FM&P), Room 3D-826
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(202) 695-0711.